the Cornell

engineer

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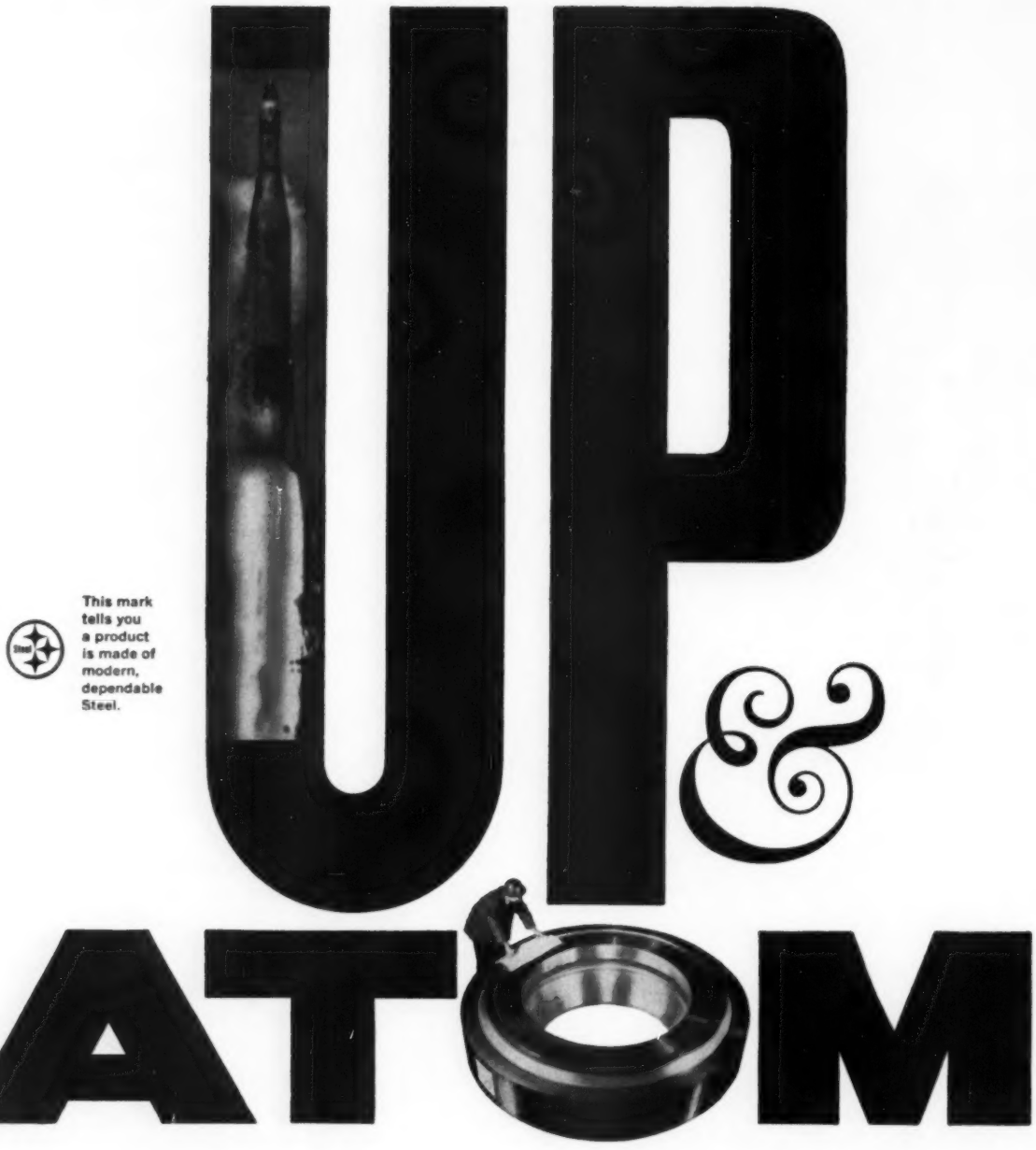

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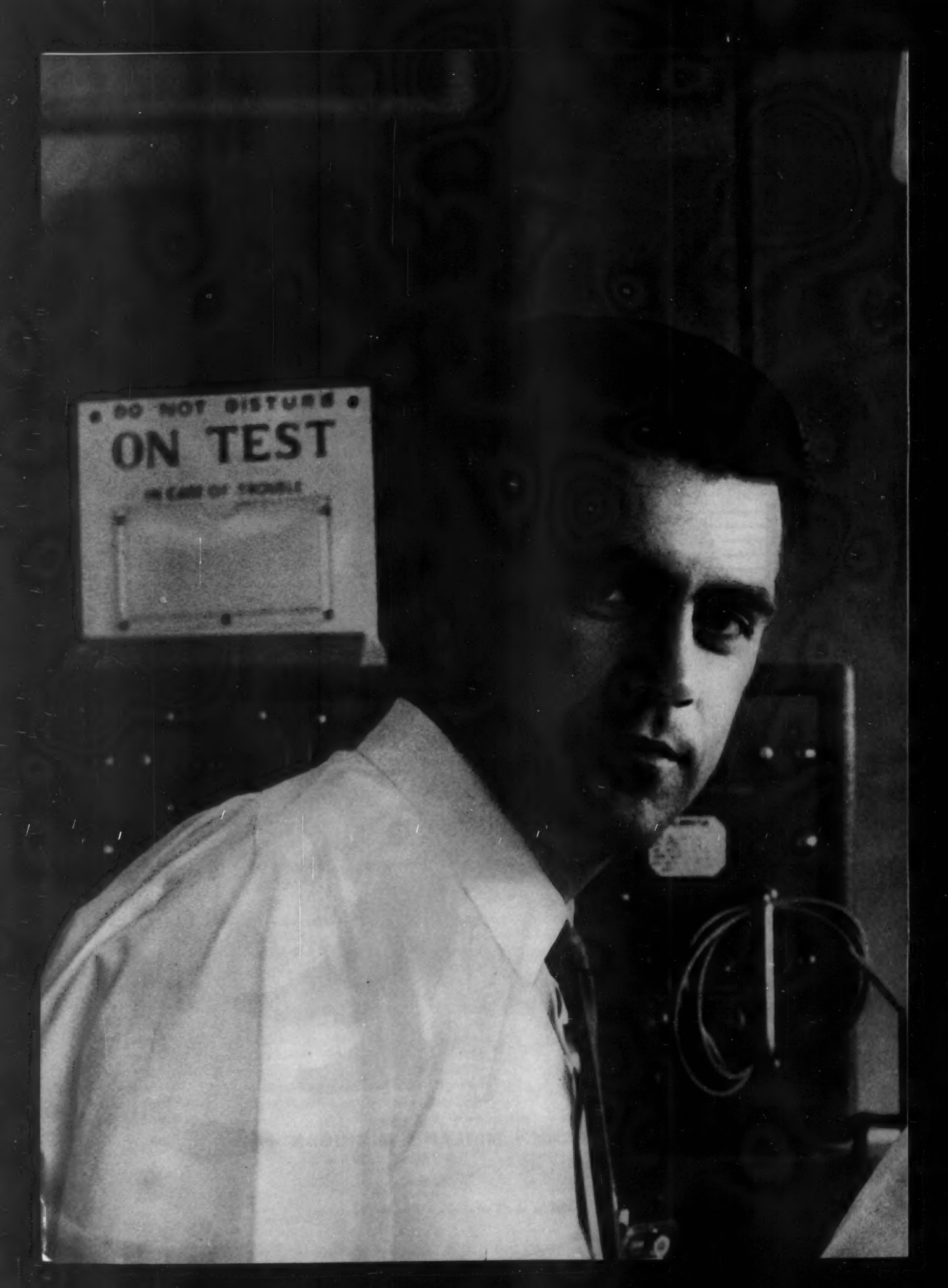
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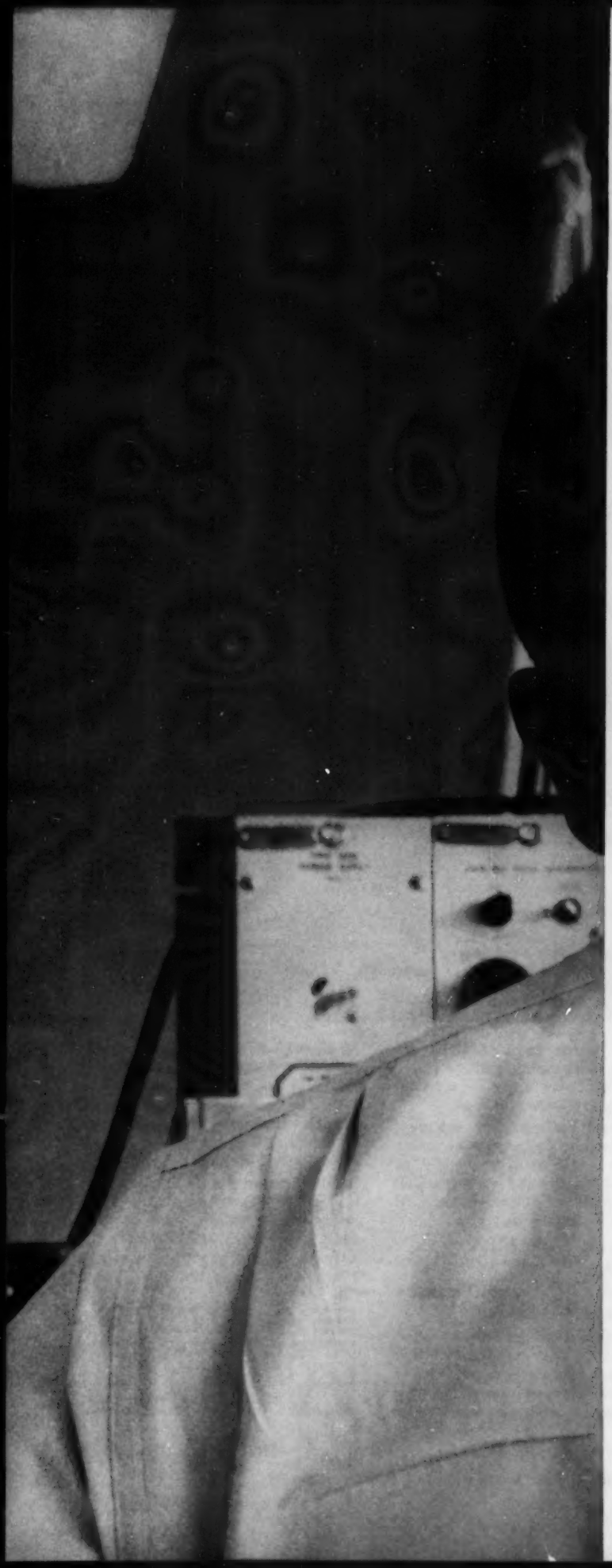

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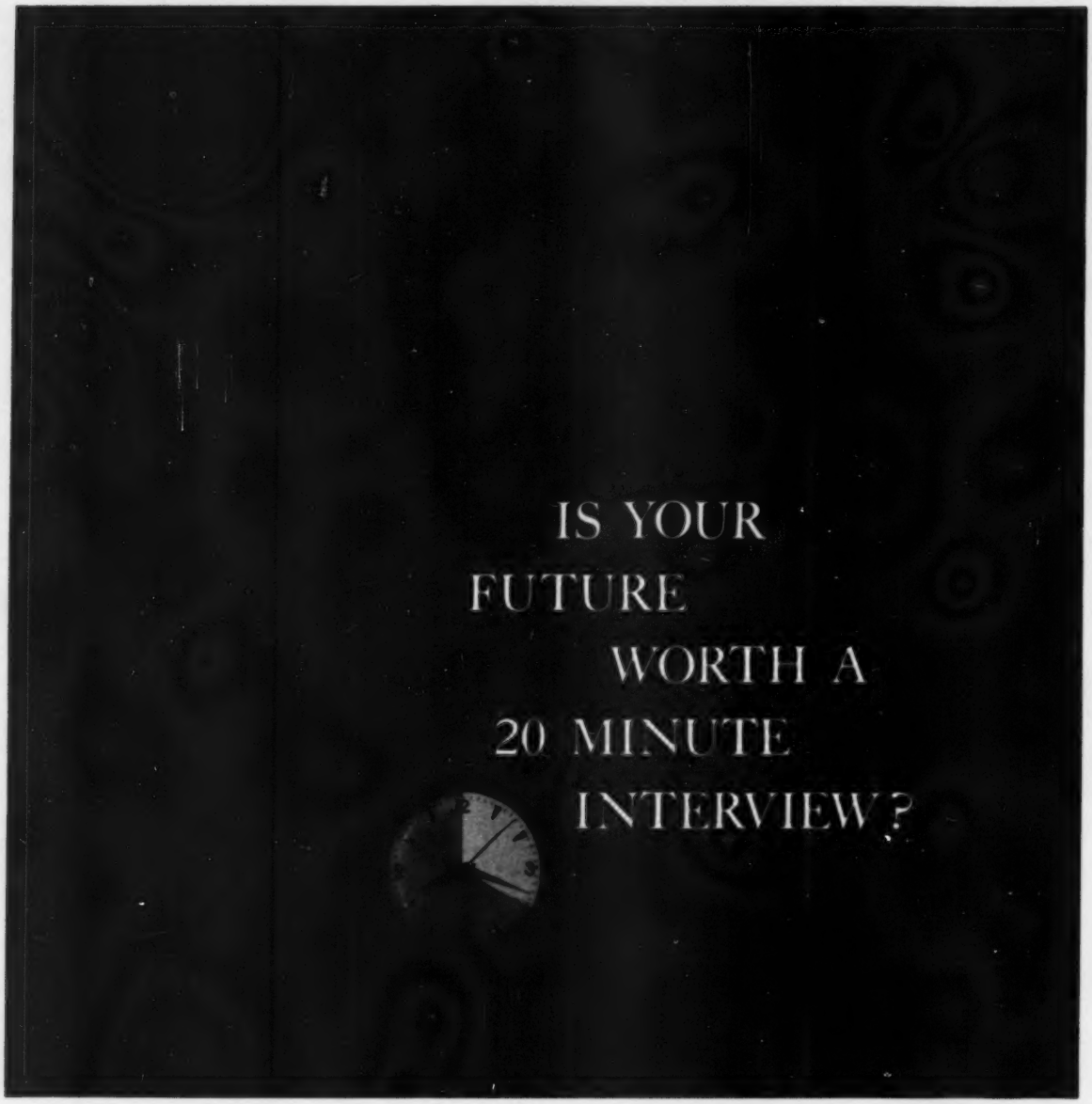

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THE CORNELL engineer

FEBRUARY 1961 VOLUME 26 No. 5

COVER shows the moon. For story on a probe designed to investigate its surface, please see page 19.

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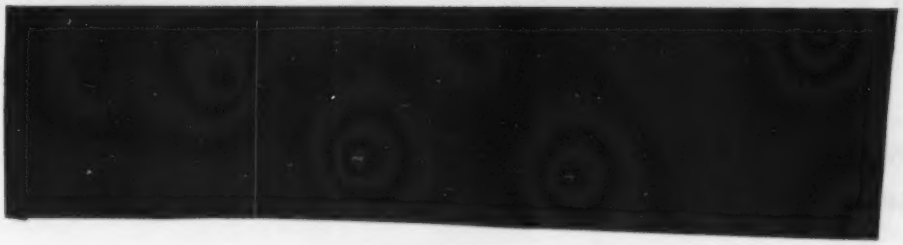

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the Cornell **engineer**

Editorial . . .

ENGINEERING — AN EDUCATION OR NOT

We have often heard the statement "Engineering isn't an education, it is a training." Nonsense! The study of engineering is no less an education than the study of the so-called "liberal arts". In fact, the statement might be better applied to its speaker. It is time that some of the misconceptions involved here be corrected.

How do we mark an educated man? We note his possession of some of the knowledge of mankind, originality, creativity, an insatiable thirst for knowledge, breadth of interest, and open-mindedness.

What distinctions do we make between "education" and "training"? We expect originality and creativity in connection with the former. The painter requires training for his art, but this is not enough. Similarly, the engineer requires training for his art, and that is not enough. He must be creative. It is his responsibility to adapt the discoveries of science to the needs of man. His products must be useful and economical. And often he must solve a problem never before dreamed of (unless by Jules Verne). This requires originality—just try it!

It is said that an education is never completed. What is meant? Don't we expect that an educated man's thirst for knowledge should never be satisfied? Certainly this is true of the engineer, as the number of technical journals shows. And can't we point to the volumes of literature written by engineers about education as evidence of deep interests in other fields?

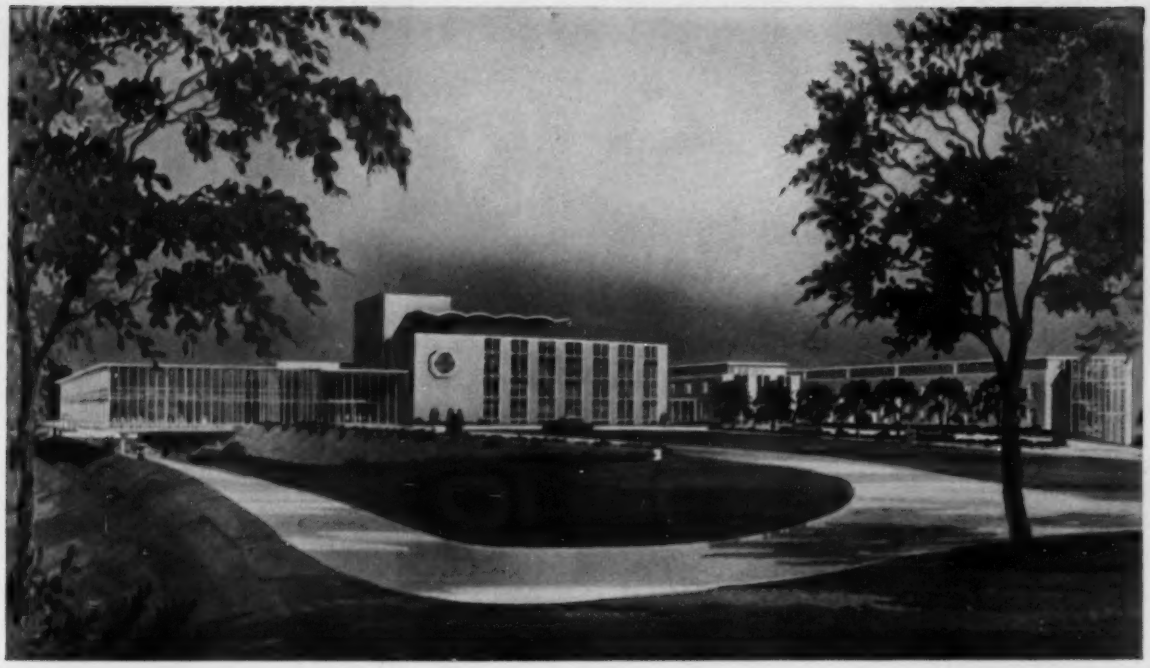
We expect breadth of interest in the educated man. Perhaps this is the solution. No! The interests of the engineer are as broad as man's present knowledge. The engineer is necessarily interested in both science and application. We know engineering students interested in linguistics, history, government, and philosophy, just to name a few areas. True, they spend most of their time studying technical journals. Are they different from the students who will concentrate on Russian government? A different concentration, a different field—a different personal preference.

The sun, a campus newspaper, suggests in its January fifth issue that ". . . perhaps **the** difference between the arts and engineering schools, is the extent of the student's command of course material **beyond** the course's minimum requirements." We see no difference here —unless the arts student need only meet some sort of minimum requirements to be successful. The successful engineering student, like the arts student, learns a great deal beyond the minimum requirements because of his personal interest in the subject. In both schools there are those who aren't interested beyond an arbitrary set of minimum standards.

It seems that some critics refuse to recognize the fact that people study engineering because they are interested in it. "Of course all engineers are studying engineering because there is money in it," they would say. Why not be a doctor or lawyer or rock-and-roll singer?

What is left? Why aren't the engineers "educated"? Perhaps some feel that there is something more noble about the study of the so called "humanities." John Ray Dunning, Dean of the Faculty of Engineering at Columbia University, suggests that this is the reason for statements like the one in contention. He writes that there persists a view which should be called "myopic humanism" which holds. ". . . that the supreme accomplishments of human life—art and philosophy—are somehow n o n-physical, and therefore superior to the understanding and manipulation of physical environment, which is after all only a kind of clever housekeeping that makes the life of the spirit possible." It seems to us that these people who fail to recognize that engineering is a study undertaken because of personal interest, who fail to recognize it as a worthwhile endeavor even when confronted with its creativity and benefits to mankind, are much more narrow-minded than those they accuse. No, we won't say they haven't received an education—but they have missed part of its point.

R. T. F.



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THE MASER

NEW DEVICE WILL AID LONG-DISTANCE COMMUNICATION

by Robert Stern, EE '63

In a few decades, when space flight has become a reality, man will need a dependable way of sending information across the reaches of the universe. On earth, the demand for more and better methods of communication will become more pressing. Since most means of long distance communication, such as radio, television, and telephone, depend on the use of radio waves, improvements in their use must soon be made to meet this ever-growing demand.

With man's increasing use of the airwaves, communication has become more complicated and cramped. Only a limited amount of space in the radio spectrum is still available for new communication channels. One of the relatively unexplored regions in the spectrum is the microwave frequency range. At these high frequencies, there is more room than in all the wavebands now in use. Microwave relays are already in use by the intracontinental television networks and by the telephone companies. But the use of these ultra-high frequencies also presents some problems. Conventional vacuum tubes will not work in this region; other types of amplifiers also become ineffective as the frequencies become higher. Recently, a new device has been developed which will fill the gap which vacuum and other types of tubes have left in microwave communication equipment. This new device is called the maser (for Microwave Amplfication by Stimulated Emission of Radiation).

Basically, communication by radio waves demands three principal components: a transmitter, a receiver, and an antenna system to radiate and pick up the transmitted signals. Theoretically, there is no limit to the power which can be generated and then transmitted. It is possible to design an antenna system capable of transmitting and picking up radio waves quite efficiently. But in the actual reception and translation of radio waves into something meaningful, a problem occurs: it is impossible to receive radio signals which are themselves weaker than the random electrical "noise" which is always present in the receiver. The static (random electrical noise) drowns out the weak signal, much as one coat of paint will cover a previously applied coat.

For practicality, the size of a transmitter or antenna cannot be too large; in the case of a spaceship, the sizes of both would be severely limited. The only alternative is improvement of the receiver. The size of the receiver will not be materially increased by improvements, whereas both a transmitter and an antenna must take up more room as they become more powerful. A radio receiver is made up of an amplifier, a demodulator, and some sort of output device, usually a speaker. Common receivers, such as the usual AM radio, use vacuum tubes which depend on hot filaments which emit electrons in order to amplify signals. Electrons flying around in an electrical field create random thermal and electrical noise whose strength is often higher than that of the incoming signals. Hence, the weak signal would be lost and only the noise would be heard.

Maser Application

It is in the field of amplification that the maser has its most important application. The maser operates at temperatures approaching absolute zero—the coldest temperature attainable. At such low temperatures, atoms are slowed down to a near standstill, so the electrons generate very little thermal noise. Obviously, there can be no vacuum tubes operating at these temperatures. How, and why, then, does the maser work?

It is known that atoms can exist in many states or energy levels, corresponding to the amount of energy which the atom contains. Electrons can gain potential energy or lose it in normal processes. In any type of energy change within the atom, the governing law is Bohr's postulate or frequency condition: $E_{12}=hf_{12}$, where E_{12} is the energy change between any two energy levels, h is Planck's constant, and f_{12} is the frequency of the photon which is emitted or absorbed during the energy change.

MIT Lincoln Lab.

The radar installation at MIT's Lincoln Laboratory. A maser was used at the focus of the antenna to amplify radar signals returning from Venus.

A photon (which is nothing but a small amount of energy traveling with a wave frequency F_{12}) must be omitted if energy is to be conserved.

If an atom somehow is excited to a higher energy level, it must have absorbed energy, possibly in the form of a photon. Let E_{13} represent a change from energy level one to energy level three which may have occurred. It is now possible for the atom to lose energy in a number of ways; it can emit a photon of frequency f_{32} and fall to energy level two, or it can emit a photon of frequency f_{31} and fall back to level one. In each case, a photon of energy hf and of frequency f_{32} or f_{31} is emitted. This changing of energy levels goes on spontaneously and continuously in all atoms. The probability that energy will be absorbed is equal to the probability that energy will be emitted. Therefore, in a normal group of atoms, exactly the same number of atoms will rise to higher energy levels as fall to lower levels. Since an atom tends to stay in its lowest energy level, there will be an equilibrium where the same number of atoms are increasing in energy and decreasing in energy; the net effect being a preponderance of atoms in low energy levels with fewer and fewer atoms in the population of the higher energy levels.

The "Energy Pump"

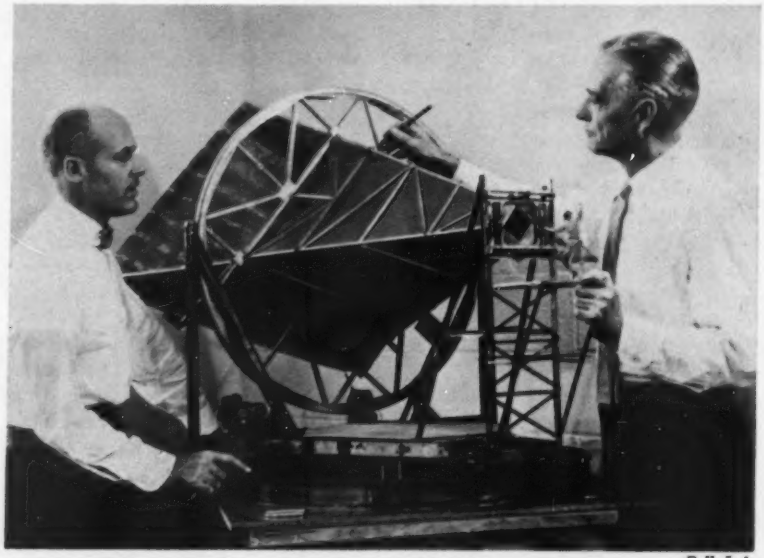
If it were somehow possible to excite atoms artificially into higher energy levels, it would be more probable that the atoms would lose energy, thus emitting photons. These photons would then add their energy to that of the weak signal which is to be amplfied, and, since the addition of energy to an incoming signal is defined to be amplfication, the input signal would be amplified. In practice, it is possible to produce this effect, and herein lies the principle of the maser.

An "energy pump" is used to excite the atoms in the maser material to higher energy levels. The pump is usually a high frequency oscillator which operates at about two or three times the frequency of the signal which is to be amplified.[1] The higher frequency waves contain more energy and hence have a higher frequency than the input signal, so atoms are raised to an energy level from which they can fall, giving up energy to the input signal in the process.

It appears that the maser is a very elementary device which should have been invented years ago. This, however, was not the case, for a number of reasons. First of all, at room temperature, and for most materials, the chance of finding enough atoms in the energy level used in masers is very small. An atom tends to remain in its lowest energy level, and furthermore, since the probability of an atom increasing its energy is exactly the same as the probability of an atom decreasing its energy, there is no spontaneous tendency for more atoms to be in a higher energy level. For these reasons, the maser must be operated at low temperatures so that the probability that an atom will stay in a certain energy level is increased. Once atoms are excited by the pump oscillator, they will stay excited for longer periods of time. Special materials must also be used, for even at low temperatures, most materials still lose energy too fast to be of any use in a maser.

It is only within the last ten years that the necessary techniques and materials for maser operation have been developed. The details of choosing the maser material and processing it for use are too complicated to describe here but in fact most masers use ruby, which is just aluminum oxide contaminated with a few chromium atoms. The ruby is in a crystalline form and is easy to handle. Once the maser has been cooled to a temperature of about four degrees above absolute zero, the pump is turned on.

Energy pumping is achieved in a variety of ways, each depending on the proposed use of the particular type of maser. The first maser used gaseous ammonia molecules as the active material. There was no actual pumping; electrostatic fields merely separated the atoms which were found at high energy levels from those which were at low energy levels. Since at any one time, some atoms are likely to be in a higher energy state than others, it was possible to separate the two kinds and feed the high molecules into a cavity (an electrical device often used at high frequencies; it usually looks like a large elaborate metal can or box). The cavity had a very high efficiency, so that little energy was lost and most of it could be used for amplifying a signal. But the ammonia maser is not used as an amplifier; its low loss and the characteristic vibration frequency of the NH_3 molecule make this first maser a very accurate atomic



Bell Lab.

Original model of "sugar scoop" antenna used at Holmdale, New Jersey. Signals reflected off the Echo satellite were received using this device and a maser amplifier.

clock. But another type of exciter which has been used is the one called an "optical pump." This pump makes use of light to excite atoms to higher energies. The atoms then lose energy by means of photon emission as do the other types; this maser is also used as a frequency standard and is a great help in a type of spectroscopy.[2]

Most masers today use a paramagnetic material which can be pumped by reversing the spin of some of the electrons in the atom. A paramagnetic material is one which exhibits some slight amount of magnetism due to some unpaired electrons. The spinning of an electron generates a small magnetic field; but the field is usually cancelled by another electron which spins in the opposite direction. In the paramagnetic materials however, some magnetic fields are not cancelled, resulting in a small amount of magnetism. Since ruby is one of these materials, the process of pumping in ruby will be described.

Either of two methods may be used in pumping the ruby maser, but both use the same principal. Any atom whose electrons are spinning in a particular fashion has a certain amount of energy. If the ruby is now put in a magnetic field, the spinning magnets (electrons) tend to line up their little magnetic fields with that of the externally applied field. When a steady state is reached, the atoms have a certain energy. If the spinning electrons now have their spin reversed, the energy of the atom increases because the electrons need energy to align themselves against the external magnetic field. There are three ways of reversing the spins of the electrons: one method "flips" the electrons over by means of an external magnetic field; another uses a strong microwave pulse which quickly reverses the spins and is then turned off; the third method in effect reverses the spins by reversing the magnetic field which has been applied, thus aligning the spins against the magnetic field. Two-level pumping must be pulsed. Since only two energy levels are involved, the pump cannot be run continuously because

Bell Lab

The transmitting and receiving installation at Holmdale, New Jersey. The cabin at the apex of the antenna in the foreground contains the maser device used to amplify the signals bounced off the echo satellite.

energy from the pump would affect the input signal adversely. The resultant output would in no way resemble the input signal since the pump generates signals of random phase and tends to cancel the input signal. By using pulsed pumping, the atoms are excited, the pump is turned off, and the maser is allowed to amplify; then the whole process is repeated. This method is very inefficient because the maser amplifies for only a short period during a full cycle and the amplification is not constant.[3] The three level maser (Bloembergen) is named after the Harvard scientist who first proposed its use. In this pumping method, atoms are excited to some energy level E_{13}. The signal which is to be amplified has a frequency corresponding to the transition between levels three and two (E_{32}). Thus, when the signal to be amplified is applied, the excited level (three) atoms emit photons and amplify the signal. This type of pumping can be continuous since the pump in no way affects the input signal.

Types of Masers

There are three main types of working masers. The simplest type is the line amplifier. Here, there is merely a waveguide—a piece of electrical plumbing—which contains the excited atoms. A signal is introduced and, in the process of passing through the waveguide, is amplified. However, this type of maser can handle only very low power; its efficiency is very much less than fifty percent, and it must be several yards long to achieve a power gain of ten. Its advantage is in its characteristic low noise factor: the ratio of output noise to input noise is only 1.004 at 300°K. A good noise factor for a conventional traveling wave tube at such high frequencies is about ten.

The resonant cavity maser is an improvement over the line amplifier. Due to the low losses in a cavity (as previously stated), a signal which enters a cavity bounces back and forth from the cavity walls many times before it emerges at the output of the cavity. The signal has more time to interact with the excited maser atoms, thus achieving more gain due to the fact that more photons will be emitted by the maser crystal. The noise figure of the cavity is slightly lower than that of the line amplifier, but increases as frequency according to the same formula: Noise Figure $= 1+\frac{hf}{kT}$.[4] The cavity has two main disadvantages: due to the low losses, the amount of photons emitted becomes increasingly larger, until the cavity tends to oscillate (emit

a steady tone at its resonant frequency). Also, the cavity has only one frequency of operation—it cannot be tuned. In order that the maser can be used, it is desirable if not necessary that it be tunable. Another problem is that the bandwidth of the cavity is very narrow. This means that the range of frequencies over which it can be used is small. Information theory tells us that unless the bandwidth is large enough, we cannot transmit all the information we want. The amount of information (speech, digits, or modulation of any sort) is directly dependent on the bandwidth of the amplifier. Thus, if we have an AM radio, we need a bandwidth of ten kilocycles; for FM radio, we need a bandwidth of three hundred kilocycles; and for television signals, a bandwidth of six thousand kilocycles.[5] From this it is seen that a wider bandwidth enables us to transmit more useful information.

The most advanced type of maser is still under development, but its advantages are already clear. The traveling-wave maser has a lower noise factor, is more stable, may be electronically tuned, and has a much larger bandwidth. In a traveling-wave maser now in use, gains of 25 decibels (power gain of 300) are possible in a tube length of only five to ten inches. This is far superior to the cavity maser described above. Such large gains in such a short distance would not be possible if the signal which is to be amplified travels at the speed of light as it normally does. The TW maser uses a slowing device which gives the signal more time to react with the maser atoms; although the linear path is short, the actual path length is extremely long. The slowing device is incorporated into the maser as a series of small metal rods which project into the waveguide like the teeth on a comb. When the input signal hits the rods, it is reflected and slowed down due to a resonance effect. Such a device was used in the recent tests of the Echo satellite; signals from California were reflected off the aluminum coated satellite and received in New Jersey by means of a maser and a large antenna.

Potential Uses

The maser is becoming more and more useful as science advances. From its beginnings as a curious physical phenomenon, the maser has been developed and applied to a multitude of uses such as long range radar—the reflected signals from very distant objects can now be picked up and viewed on a screen—and radio astronomy—the range of radio telescopes has been extended. Other uses of masers include: testing of the theory of relativity, accurate measurement of time, possible use in relaying television around the world, and checking the speed of light.

Recently, a type of maser, a light maser, was developed. By use of a ruby cylinder, it generates a pencil-thin beam of intense light. The rays are almost parallel and hence, such a ray, if projected from the earth to the moon would only illuminate a few square miles of the moon's surface. The "laser" could be used for future communication when other frequencies are filled. Thus, the maser and its by-products have a bright future and assure man of enough room to use for communication for a long time to come.

FOOTNOTES

1. Gordon Troup, *Masers*, (London 1959), Ch. 1, *passim*.
1A. J. R. Singer, *Masers*, (New York 1959), p. 97–98.
1B. *Ibid.*, p. 98.
2. N. A. Rosa, "Light-Amplifier Breakthrough," *Electronics Illustrated*, IV (January 1961), p. 108.
3. Singer, *Masers*, p. 73.
4. Troup, *Masers*, p. 70.
5. Rosa, *Electronics Illustrated*, IV, p. 108.
5A. Martin I. Grace and Joseph G. Smith, "The Maser," *Electronics World*, LXIV (November 1960), p. 38.
6. Rosa, *loc. cit.*, pp. 43, 108.

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CORNELL STUDENT DESIGNS LUNAR IMPACT PROBE

by Jeremy Shapiro, ME '62

Cornell U. News Bureau

DESTINATION MOON—Inspired to enter rocketry by a moving picture of that name, Julian I. Palmore, engineering physics major, has won the American Rocket Society–Chrysler Corporation Undergraduate Student Award just 10 years later. His paper, "Lunar Impact Probe," won the Cornell student a $1,000 prize and a citation presented at a dinner in Washington, D.C.

Lunar Impact Probe

A basic requirement of the Bachelor's degree in every Cornell engineering curriculum but civil engineering is completion of a fifth year project by each candidate in his major field of study. All of the projects involve a good deal of original and independent thinking. Occasionally one of our students becomes involved in a project that is more than just an interesting, educational study of some engineering problem, but one that can actually provide important new information about the problem under investigation, and sometimes even present a solution to it.

Such was the project submitted by Julian Palmore III, EP '61, on the design of a lunar impact probe. His design is probably the first one developed in this country, and represents a concrete method of investigating the moon's surface.

The definite need for a probe to gather information about the nature of the moon's surface becomes obvious when one considers the various theories concerning it. Professor Gold of the physics department at Cornell contends the moon's surface "is similar to the one you would get if you took thousands of ping-pong balls and glued them together in layers — very light and very rigid, but not capable of supporting heavy material that isn't properly designed." On the other hand, some scientists feel that the surface is solid, while a third group maintain that it is completely composed of dust.

Obviously, any design of equipment for lunar exploration cannot be done without a knowledge of the surface consistency, as the possibilities provide vastly different design requirements.

After many months of study, Palmore arrived at a final solution thought to be so comprehensive by the American Rocket Society that they awarded him their annual $1000 prize for the outstanding technical paper on space sciences by an undergraduate during the year 1960.

Here is a resumé by Palmore of the basic features of his lunar impact probe:

Need for Lunar Probe

The nature and exact structure of the lunar surface is a problem with plausible but unconfirmed solutions. The importance of obtaining information about it cannot be overemphasized since manned exploration of the solar system will begin within fifteen years, and detailed knowledge of the moon and the planets is essential to the design of space ships and surface vehicles. Because there exists a lead time of several years in the development of vehicles and other surface operating equipment, it is imperative that the necessary surface data be obtained as rapidly as possible.

A second and more important scientific reason for examining this structure is that knowledge of the surface accounts for much of the past lunar history and holds a key to the origin of the solar system. The surface structure can relate the lunar past very effectively since little erosion has occurred compared to the amount that has occurred on the earth.

Proposed Surface Structures

The basic distinction to be made between the proposed surface types is that a lunar surface material may be solid and therefore moderately substantial, or a dust. Usually an increase in material density is accompanied by an increase in the stiffness and strength of the material. Therefore, the properties of the surface would be directly related to the resistance it offered to penetration by a projectile. If it were found that little resistance were offered, a dust would be the more probable structure.

"Hard Landed" Versus "Rough Landed" Probe

One way the needed information can be obtained is through the use of "hard landed" instrumented probes which can be developed rapidly for use within a year or two. Basically, the distinction between a "hard landed" probe in contrast to a "rough landed" probe is that the former falls to the surface with a velocity approximately equal to the lunar escape velocity of 2.35 km/sec (7710 ft/sec) while a "rough landed" probe employing retro-rockets could land with a possible error of a hundred feet per second, depending on the accuracy of the vehicle control.

Determination of Surface Properities

The fundamental idea associated with a determination of surface properties by an impact probe is in measuring the elastic compression wave generated on impact followed by a destructive plastic wave in the probe. The maximum elastic wave strength is determined by the yield point of the probe material and the dynamic elastic properties; however, the stress increase with time at a sensing station depends upon the surface properties and the probe geometry.

By varying the basic geometry, it is feasible to distinguish between different types of surfaces by measuring the decceleration of the material at a station in the probe removed from the initial impact point. The distance this station should be from the impact point depends upon such parameters as 1) the velocity of plastic waves in the material compared to elastic waves, thereby defining a time limit in which useful information can be obtained before destruction of the probe, 2) the velocity of impact and time of subsequent penetration into the surface. The penetration speed (assumed essentially constant for the transient portion of the probe geometry) determines the resultant stress on the probe. The elastic wave contains the essential data subsequently broadcast to earth. The data must be analyzed for surface information by comparison with calibrated curves of force as a function of time for various surfaces before the lunar mission.

Julian I. Palmore

WHY MAN MUST ACHIEVE SPACE TRAVEL

by Julian Palmore III, EP '61

In the past several years the possibilities for putting man into space have increased to the point that it is advisable to discuss some of the reasons that man should and shall go into space. I shall not discuss a particular program, rather the general scheme. There are five outstanding reasons for his adventure:

Overall Medical Advances

In the late nineteenth and early twentieth century many historians and some predecessors of the modern day science fiction writers tried to describe the state of the world fifty to 100 years hence. Jules Verne and H. G. Wells are among the best known of this group today. The members of this group (by no means singular in history) prophesied the effects produced on future society by developments occurring within the human race. Present-day readers will note that only one or two fields were chosen by Verne to establish the picture; H. G. Wells, however, showed insight into the nature of the problem by looking at the overall scheme.

The state of advancement in a particular science depends upon advances in other fields. Today, chemistry stands on foundations established in physics while at the same time, important new discoveries are being made in medicine because of the work of the chemist and physicist. The space frontier will open new aspects of medical science in that the conditions in space, primarily weightlessness and the effect of cosmic rays on living organisms, cannot be reproduced here on the earth. The action of the body and mind under conditions of extreme isolation and boredom can only be duplicated with the additional effect of the volunteer test environment interactions being introduced under highly artificial conditions. Psychology will benefit from man's experiences in this new environment. Gradually, as the developments in the field expand, the sociological aspects of the group emerge. Knowledge in one field supports advances in all fields. Therefore, we cannot afford to overlook these new interactions. It is possible that knowledge obtained in space may offer successful avenues of approach toward solving many of today's medical problems.

The Compelling Urge To Do So

This aspect is the one most frequently advocated by space flight enthusiasts and denounced as unrealistic by the opponents of manned space flight. This reason exists and must be contended with

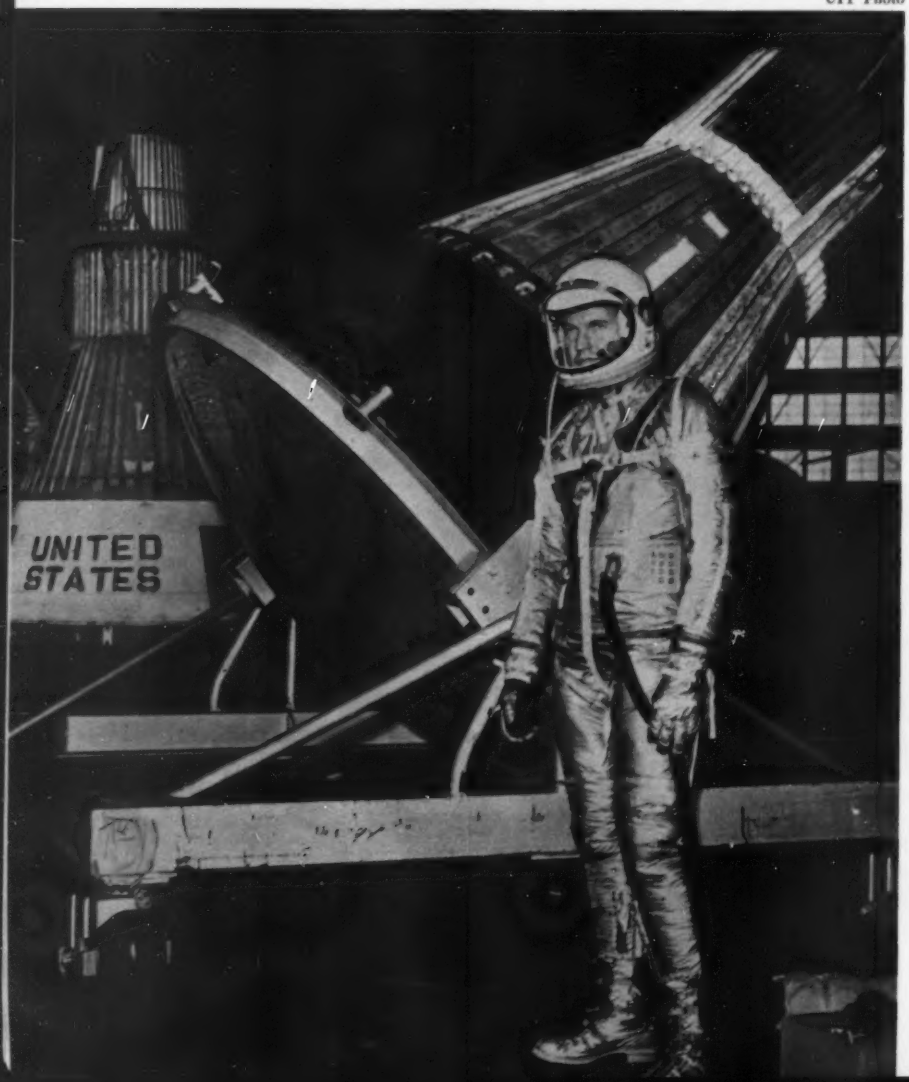
in the approach to new frontiers. Some seek space travel as a means of escape, some seek it for the psychological and moral opportunities presented. Some seek travel in space for the beauty and adventure of a new frontier, a new depth in man's experience.

Man As An Instrument

This is a startling title as a reason given for man's adventures into space. The main point is that men *can* do some things which ininstruments cannot, surprising as it may seem! An old scientific saw exists with respect to opposing travel through space. The saw is paraphrased as follows: man's sensory apparatus is limited to detecting a narrow band in the entire spectrum of knowledge existing today. Man cannot see cosmic rays, but his instruments can, etc. Why then send men into space since this limitation exists? The reason for manned flight is that this limit does exist for the quantity and quality of information man can receive. An instrument has an inherent limitation in that it cannot outthink a man. At least, no instrument capable of being put into present day American space vehicles can! A man in space or on the surface of a planet can make a five minute observation that would put an instrument to shame. In exploring unknown environments, whether it be the world of the atom or the depths of the universe, man develops instruments as tools. In no cases has a man developed an instrument to replace himself before he has gone into the new environment *if it is possible for him to do so.* In the preceding article, the paper "Lunar Impact Probe" was discussed. This device was designed to investigate the lunar surface material without the necessity of surviving the lunar impact. For planetary exploration such an instrument would be unsuitable if launched from the earth. This is because there is no way known at present to select a suitable impact point. A geologist, however, on the surface of the planet, could make a several minute investigation which no instrument could do. Another striking limitation of an instrument is that data is obtained; but in many cases too much data. For example, in the flights of sun orbiting satellites passing through the Van Allen radiation belts, on their outward journey much data was obtained. Enough to analyze for about three years! Only a human being can ultimately decide what data will be of value to himself. If no way is known to predict the exact condition existing on planets, how can the instruments be designed to account for the unexpected?

Wearing an aluminized space suit, Mercury Astronaut L. Gordon Cooper stands near a Project Mercury capsule at Langley Field, Va. The capsule, and another one in the background, are prototypes of the one in which Cooper or one of the six other Astronauts will ride into space in the near future.

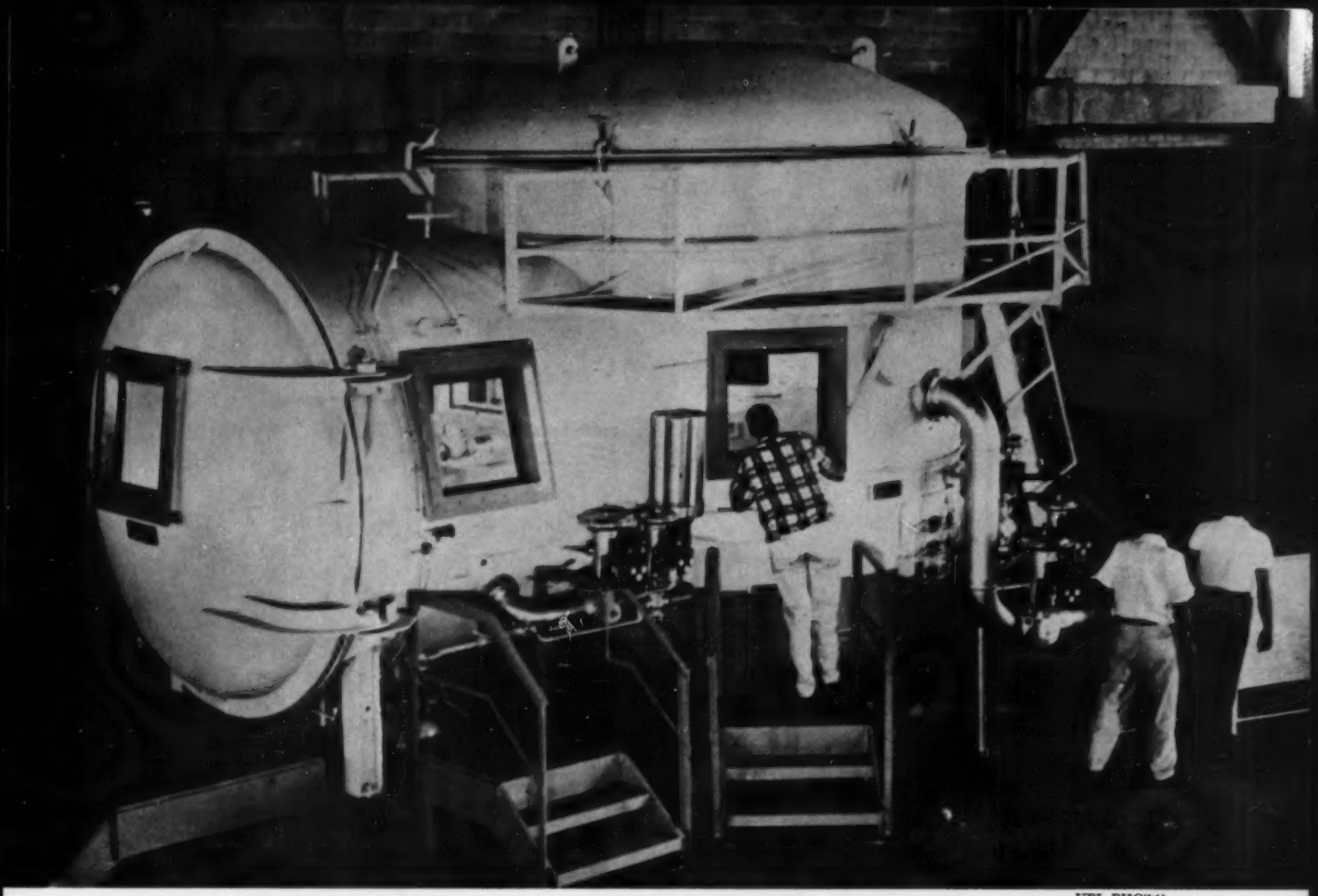
UPI Photo



Reviewing scientific developments one finds in general that many observations, and in some cases experiments, are required to enable the investigator to develop a suitable theory explaining the phenomenon. No instrument can be developed to replace the human intellect in the discovery of new phenomena in inaccessible places unless it has the power of the human intellect, the power to appreciate that which the human intellect appreciates.

For Philosophic Reasons

The other reasons lead to the philosophic reasons for going into space. Man appreciates many phenomena: the rising of the sun, the silence of a desert, a full moon. He views many objects, he experiences many stimulants. He appreciates much of what he senses. He calls some of these sensations: beautiful, pure, awesome, terrifying. It is a true interaction with his environment. These cannot be appreciated through numbers and measurements in many cases. Man seems to enjoy much of this in-



UPI PHOTO

Technicians look over a unique Project Mercury high altitude simulator at Cape Canaveral, Florida. The simulator will be able to accommodate an astronaut in a "Mercury Pod" and reproduce conditions existing 45 miles up. The astronaut's reactions can then be studied by scientists through windows in the high altitude test chamber.

teraction. Some is vital to him, much of it is not, in that he could "survive" as a living creature without it. Space is the first environment in which it will be possible for man to sense the interactions with the third dimension of space. Essentially, we live in a two times one dimensional world, that is, two dimensions of space, one dimension of time. Immersed in the third dimension (being in a condition that all three dimensions are sensorially equivalent) may prove to be of much stimulation. One cannot overlook this fourth reason.

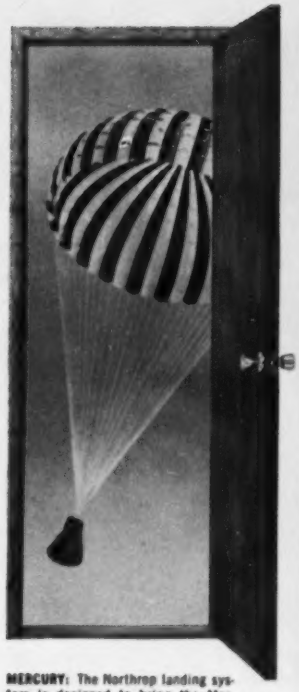
Missed Accomplishments

I mean this in a sensible way and do not intend it to mean the reason that one does not walk into a holocaust. A simple example may illustrate the problem. If, for some reason or other, doctors decided a priori that cancer could not be caused by viruses in any conceivable instance, and adopted the rule that no doctor would be allowed to investigate the causes of cancer from this point of view, the above reason stands out clearly.

Of course the opponents of space flight may still question the value of all the above reasons listed for the important question of financing such a venture. Let me first say there are two classes of opponents of manned space flight: the first is the group that admits of the need for instrumented exploration; the second advocates *no* exploration at all. Most scientists listed in either group are listed in the first. The expenditures necessary in this case are additional, and I think considering the development of such systems as the one or two billion dollar B-70 being developed, one may safely disregard the financial aspect. The second group is morally right in asking the question, for being concerned with human burden on earth, the entire financial burden of space exploration appears questionable. No program for the benefit of humanity should suffer for space exploration. What can afford to suffer? Possibly some of the waste that exists in the country today in government, industry, and especially personal life. Much of the defense spending is a necessary and essential safeguard in today's world. Careless thinking in government and industry can cost the country billions of dollars and precious time. Careless thinking in a person's life can cause him grief immeasureable in terms of dollars and cents. The important point is this: the country has the capacity to meet the challenge of space with the only sacrifice being the waste accumulated within today's society. If the space program were only another financial burden on the taxpayer it would not be worth the money. But it is more, much more than this. It is one of the programs adding to man's capacity to understand, to comprehend. It is a future investment in the human race.

POLARIS: Northrop's Datico checks out Polaris at all levels of maintenance and operation.

SKYBOLT: Guidance and navigation systems are being developed by Northrop for this new and highly secret air-launched ballistic missile.



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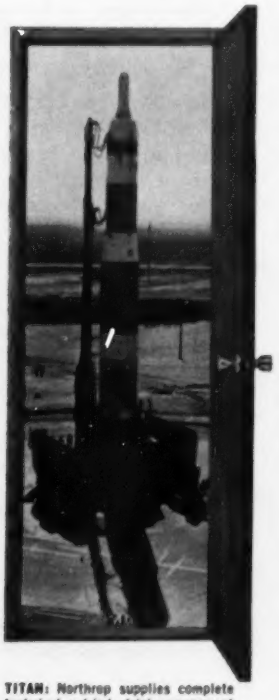

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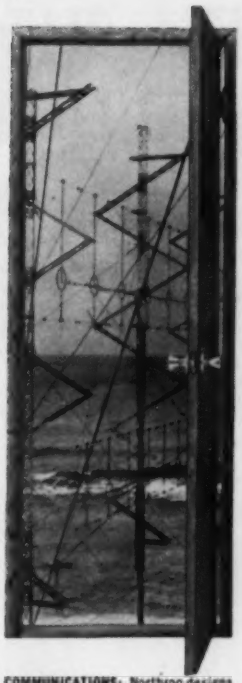

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THE NEW BASIC STUDIES PROGRAM

By Donald H. Moyer, Director
Office of Student Personnel
College of Engineering

The latest step in the curricular development of the College of Engineering is the establishment of a Division of Basic Studies, designed to provide a two-year common program for all engineering students, in which emphasis is to be placed on preparation in science, mathematics, and engineering science fundamental to technological study in any branch of engineering. Its further purpose will be to assist freshman and sophomore students in their choice of a branch of engineering.

Since Cornell's founding, nearly one hundred years ago, the faculty of the College of Engineering has been mindful of the needs in engineering education; in particular, a sound foundation in science and mathematics and in engineering science, and a program of technological studies which would faithfully transmit from one generation of engineers to the next the methods and practices which have come to form the heritage within each engineering discipline. The proper balancing of these factors has not been easy; Cornell extended its curricula to five years to provide what it thought to be the essence of good engineering education; other colleges in the traditional four-year span have often resorted to imbalance, leaning heavily to engineering science on the one hand or technology on the other.

Background of Program

In large measure the Division of Basic Studies will consolidate the academic developments of many years in engineering at Cornell. Ever since the creation of the five year curricula in 1946 the College has offered essentially a common program of studies for the first two years. There were minor peripheral differences, as for example in the drawing courses, surveying, and the chemistry courses for the chemical engineers; but at least, with the exception of chemical engineering, a student could transfer from one division to another up to the end of two years without appreciable penalty. The core of each curriculum in the freshman year has been mathematics, physics, chemistry, and English, and the basic studies program will incorporate all these. Each School has handled graphical representation in its own way, and each has provided its own orientation dealing primarily with the subject matter of its own branch. In the second year mechanics and materials have in one manner or another been a common requirement along with the continuation of mathematics and science. Beyond the sophomore year the engineering science courses have tapered off, with the notable exception of engineering physics, while each branch has developed its sequences of technological courses combined in all instances with prescribed and elective courses in the humanities and the social sciences.

One of the chief criticisms which has been leveled at the five-year curricula is the obligation placed upon prospective students to select a branch of engineering at the time they matriculate in the College. Despite the protestation that such a commitment need not be an irrevocable one, there is little doubt that some students for this very reason have been dissuaded from even making application to Cornell. Certainly it has been evident that a large proportion of our freshmen have made only a tentative choice of engineering field, and it is equally apparent that among these have been a considerable number who in the first two years have found it difficult to arrive at a firm conviction as to their ultimate engineering objective. The basic studies curriculum is being designed to meet these problems more realistically and at the same time retain the more desirable attributes of the previous first two years of the five-year programs.

Cornell U.

Carpenter Hall, which houses the administration offices and library for the college of engineering.

Basic Curriculum

Beginning with the fall semester of 1961 applicants to the College of Engineering will be asked only to state a preference for a branch of

engineering; all will matriculate for the freshman year in a single Basic Studies curriculum of mathematics, physics, chemistry, English, and a course to deal with engineering problems and methods. This last course is an innovation, forming a three-semester sequence for the purpose of acquainting students at an early stage with graphical representation, measurements, and methods of computation; its other phase will endeavor to present to freshmen and sophomores through their active participation the nature of engineering as a profession, as well as investigations of its various branches and their functions. This will afford an early means for new students to form intelligent judgments concerning their ultimate occupational objectives. A program in mathematics and physics will continue for all students in the second year and a first course in mechanics will begin then. In addition, all students except those in chemical and metallurgical engineering will have the third semester course in engineering problems and methods, semester courses in chemistry and materials science, a two-term liberal elective, and a one semester professional course to be specified by the professional division in which the student at the end of his third term has tentatively expressed a preference. Some students may be permitted to defer one of the liberal electives in order to take a professional course in a second alternative area in the fourth term. In addition to mathematics, physics, and mechanics, students expressing an interest at the end of the freshman year in chemical and metallurgical engineering will take three courses in each semester of the sophomore year to be specified by the division of their choice.

Indication of Preference

While under this program most students will not be obliged to commit themselves to a branch of engineering until the end of their sophomore year, each will be asked for any preference he may have at the time he files his application, when he matriculates, and at the conclusion of the first year. From the time he enrolls each student will be assigned an adviser in the field of his expressed preference if any, and the faculty believes that together with the courses in engineering problems and methods and the exploratory professional courses all students should be well prepared by the beginning of their third year to establish a valid vocational objective.

Students will be admitted to the professional division of their choice on successful completion by uniform standards as specified by the Division of Basic Studies of: 1) the required curriculum of the Division of Basic Studies and 2) the sophomore course or courses, if any, required by the division of the student's choice.

Details of the foregoing curriculum are still subject to final determination by the faculty and by the Director and Executive Board of the Division of Basic Studies. This board will be composed of six members of the engineering faculty plus not more than five non-voting advisory representatives from departments outside the College which provide freshman and sophomore instruction.

Cornell has often pioneered in engineering education, and while this common program for freshmen and sophomores may not be a new concept it does incorporate long-tested elements of engineering education with a perceptive approach to student psychology. While recognizing that engineering practice has its roots in mathematics, science, and engineering science, it assumes that the traditional engineering disciplines, however modified they may one day become, are still an integral part of engineering education. It is not, therefore, designed as the precursor of a common engineering program for theorists only. Researchers we must have, but likewise we must educate people to build bridges, develop machines, design apparatus, and operate the manifold complexities of the manufacturing world. Cornell proposes to do just this and considers this latest development of the College as a constructive step forward in its unceasing efforts to provide for its students the best preparation in engineering any institution can give.

GLARE DISCOMFORT

CORNELL GROUP STUDIES GLARE EFFECTS OF LARGE SOURCES OF LIGHT

by William D. Nickles Jr., EE '65

Lighting practice has undergone a great change during the last decade. In both natural and artificial lighting, the move has been away from small windows and small luminaires towards very large sources of light.

Although large sources are often of much lower brightness than those they replace, complaints of glare or of discomfort in some form are still heard. This could be due to a general movement towards higher standards of comfort in all the things of life, or it could be due to real visual effects, so far unsuspected.

In 1956, a symposium was held at the University; discomfort due to glare was a major topic of discussion. As a result, the Illuminating Engineering Research Institute has sponsored a research project on this topic. This project, international in scope, is under the direction of Professor E. M. Strong. Dr. R. G. Hopkinson of the Building Research Station, Watford, England, and Robert C. Bradley, Research Associate, School of Electrical Engineering at Cornell, are the leading men engaged in the research.

The purpose of this project is to determine the basic relationships between glare discomfort, the brightness of a source of light and its surroundings, and the size of the source.

Background to the Study

The systematic study of discomfort effects from glare began with the work of research teams working in the United States in the 1920's. The result of this research was an expression relating the physical variables which govern glare discomfort:

$$\text{Glare Constant} - G = \frac{B_s^p W^q}{F^r}$$

Where – B_s is the luminance of the source

W is the apparent size of the source

F is the luminance of the surroundings

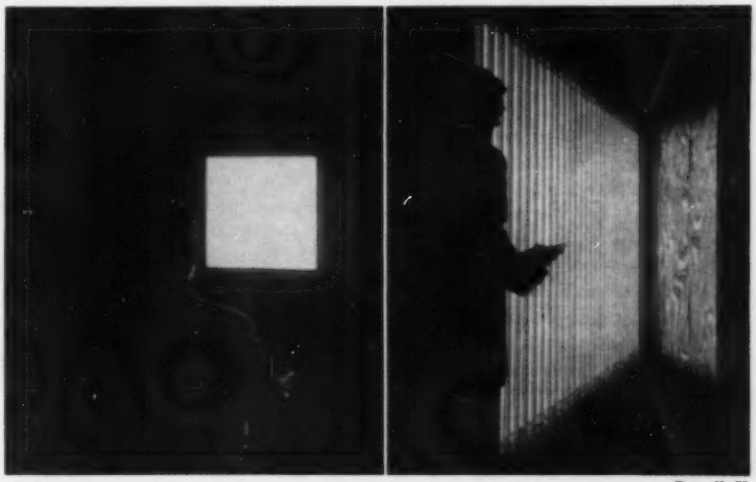
They agreed on assigning values of p, q, and r in the ratio of approximately 1.6:0.6:1.0.

However, it was found thru later research that the formula for finding the glare constant applies only when the source is not very large and does not produce a very high illumination at the eye. A detailed study of the effect of a very large source on glare discomfort was considered necessary for progress.

Experimental Arrangement

The experimental arrangement at Cornell is based on a very large source consisting of a vertical bank of closely arranged fluorescent lamps whose light is diffused by an opal plastic screen. This setup presents a large surface of uniform brightness to the observer. A system of dimmers permits a smooth control of the brightness of this source.

The surrounding illumination is provided by other fluorescent lamps set in a system of screens so constructed that a substantially uniform surrounding illumination is seen by the observer. For dark surrounding conditions all surfaces were of black cloth.



Cornell U.

Students, acting as observers, are placed in a large cloth room approximately 9 feet square in cross-section and 16 feet long, facing the glare source (see left photograph). They are asked to adjust the brightness of this glare source until they feel the glare situation they are in is, for example, "just acceptable," or "just uncomfortable."

The source (shown from the back side in right photograph) is composed of 59–200 watt, fluorescent lamps in front of which is placed a sheet of diffusing plexiglass. It can be masked to visually present useful sizes up to 7 feet square. The glare source brightness ranges–varying between 23,700:1 and 3,200:1 for different source sizes–provide for very smooth control, completely free of flicker by observer.

Experimental Procedure

The experiments were conducted by means of the Multiple Criterion Method. To begin, the source was turned off and the background set up. The observers were required to sit for approximately ten to fifteen minutes in these surroundings to adapt to the conditions. It had previously been explained to the observer what was demanded of him; first, he must raise the brightness of the source himself by means of the dimming control knob until the threshold of glare (criterion D) was reached. After this setting was recorded, the observer slowly raised the brightness of the source again, allowing pauses for adaptation, until the next degree, just acceptable glare (criterion C) was reached. Criterion B, just uncomfortable glare, came next, and finally criterion A, just intolerable glare. This experiment was run again and again with different conditions.

The variation of the size of the source as seen by the observer was obtained by a series of masks over the source, and also by moving the observer nearer to or farther from the source. This was done to prove the assumption that the governing factor in glare discomfort in the spatial sense is the apparent and not the real size of the source.

Selection of Observers

Ideally, all experiments destined to lead to general recommendations on lighting should be conducted with a sufficient number of observers to represent the whole population to whom the recommendations will apply. Consequently, while the standards of lighting provided in a private office can very well be set by the occupant himself, to be applicable to all office standards, the experiments should be based on the judgments of a representative group of office workers.

Unfortunately, studies of visual comfort are laborious and take a long time because continual repetition of a judgment by the same observer and under the same conditions is necessary in order to assess the average judgment with sufficient precision. Therefore, it becomes necessary for the experimenter to rely on the judgment of fewer observers than are ideally required.

The observers were carefully selected, not necessarily for the numerical precision of the results which they were capable of giving, but for their general cooperation. A good observer is co-operative, intelligent, quick and keen to appreciate the points of technique of the experiment. He should give of his best without in any way needing to have any knowledge of the trend of the results as a reward. He should have no preconceived theories about the experiment in which he is engaged; he should be indifferent about the result of the experiment, but conscientious.

At Cornell the observers fall within a limited age group (18–25). They are all male engineering students, and so do not come from a fully representative section of the population. This choice was deliberate, however, because experience has shown that technically trained people are more cooperative in these somewhat onerous subjective studies.

Results of the Experiments

When the work at Cornell is complete, about 10,000 observations will have been collected from a total of twenty observers. After the young engineering students were recruited, time was spent giving them experience in making judgments of glare under a limited range of conditions before they could begin the full scale experiments.

Complete sets of observations are being made in three parts, first in dark surroundings, next in a light surrounding of fifty foot-lamberts luminance, and finally in a light surrounding of ten foot-lamberts luminance with a full range of source size.

The extensive data which should emerge from the full Cornell study must be analyzed before any definite statement can be made. However, the data from the first few observations reveal some interesting facts.

Summary of Results

The chief features of the dark surroundings were:

(1) With a dark surrounding, almost the same degree of glare discomfort arises no matter what the size of the source, up to a source size of about one steradian. (A window or luminous ceiling of 200 square feet in area seen 15 feet away subtends about one steradian at the eye.)

(2) As the source is increased in size to full field, the degree of glare becomes smaller after full adaptation has taken place.

(3) When the source is very large, glare is very sensitive to changes of brightness.

(4) The level of source brightness which causes "intolerable" glare is practically independent of source size up to full field – on the other hand, the brightness which causes threshold glare in a dark surrounding is low with small sources but higher with full field.

The main conclusions regarding light surroundings are as follows:

(1) Whereas with the dark surroundings the size of the source had only a small influence on the degree of glare, with a light surrounding, the size of the source has a more marked effect.

(2) The size of the source has a greater effect on severe glare than on mild glare.

This project has not progressed far enough to derive any definite conclusions from the data, but there are several indicated relationships at this time. Perhaps the most interesting indication so far obtained is the fact that, with large sources, a much smaller change in illumination is needed to produce a given change in degree of glare discomfort. If this finding is confirmed by the full Cornell study, it will mean that in setting the brightness of, for instance, a luminous ceiling, much greater care is necessary than in the case of conventional luminaires.

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A candle in a dark room?

Transverse and/or Visible electromagnetic waves?

A universal constant?

How many wave lengths in a photon?

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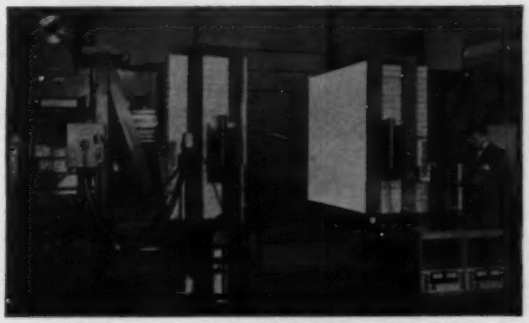
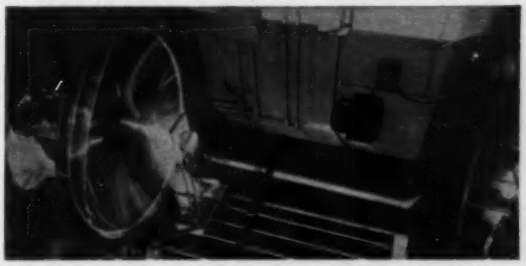


At P&WA's Connecticut Aircraft Nuclear Engine Laboratory (CANEL) many technical talents are focused on the development of nuclear propulsion systems for future air and space vehicles. With this live mock-up of a reactor, nuclear scientists and engineers can determine critical mass, material reactivity coefficients, control effectiveness and other reactor parameters.

Representative of electronic aids functioning for P&WA engineers is this on-site data recording center which can provide automatically recorded and computed data simultaneously with the testing of an engine. This equipment is capable of recording 1,200 different values per second.



Studies of solar energy collection and liquid and vapor power cycles typify P&WA's research in advanced space auxiliary power systems. Analytical and Experimental Engineers work together in such programs to establish and test basic concepts.

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Faculty Profile . . . PROFESSOR MARK KAC

by Robert Sanderson, ME '65

Dr. Mark Kac, Professor of Mathematics, and a member of the department of engineering physics, is leaving Cornell at the end of the present academic year. Professor Kac, who has been here twenty-one years, will teach and do research at Rockefeller Institute in New York City.

Professor Kac was born in Lwow, Poland. He grew up there and attended Lycee Kizemieniec, a secondary school in his home town. This background was roughly equal to two years of college in the United States; secondary schools in Europe are a good deal more rigorous and thorough than American high schools. He received his Ph.D. from John Casimir in 1937, and was awarded a fellowship to teach at Johns Hopkins University during the year 1938–1939.

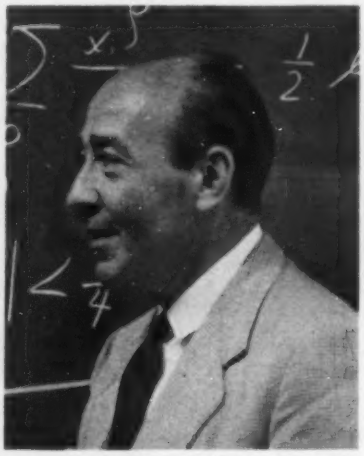
After teaching for a year at Johns Hopkins, Professor Kac came to Cornell. In keeping with the policy of the mathematics department, he has taught "everything under the sun." His first classes included two sections of trigonometry and two of algebra, but during his second term he taught graduate courses. Since then, Professor Kac has taught a wide range of subjects; his courses this fall deal with higher calculus.

Next year Professor Kac will be teaching at Rockefeller Institute, a position which his friends jokingly refer to as "retirement." The Institute, which was formerly an organization interested solely in research, now offers post-graduate degrees. Aside from his teaching duties, Professor Kac will be able to spend a good deal of time at research. He has been interested for quite a while in probability and its obligations to physics.

Professor Kac calls himself "illiterate" in five languages: Russian, French, German, English, and Polish. "I taught in Poland three weeks last year, and I was surprised how much of the language I had forgotten," he commented.

Professor Kac has also lectured at Paris, Lusanne, Amsterdam, Oxford, and Cambridge, in addition to many cities in the United States. Last month he spoke at a symposium at Purdue University.

Like nearly all professional educators, Professor Kac has many definite ideas about the workings of his profession. He believes that the mathematics department's system of evaluation, prelims and finals only, is the best possible, considering the large classes in all courses. He added that because of the great number of students taking calculus in the fall term, the course will be taught in spring term by lectures twice weekly, with only one recitation period. Professor Kac thinks that the old English tutorial system was the most beneficial to students. Under this system, one teacher would practically live with two or three students and impart to them what he had learned himself. This system is obviously impossible today because of the large number of people desiring education. As a result, both in Europe and America, the university student must be on his own to some degree. Professor Kac believes that this is advantageous if the student is mature, but nearly all freshmen and sophomores are not really mature enough.



Professor Mark Kac

"American high schools," Professor Kac says, "are friendly and pleasant—which they should be—but they do not develop intellectual discipline in students." High schools are deficient for several reasons: the trend of mediocrity—teaching everybody the same thing because not to do so would be undemocratic; outside pressures exerted on elected school boards by unhappy taxpayers, civic organizations, and alumni, whose main concern is the basketball team, and other such groups; and finally inadequately trained, overloaded, and underpaid teachers. Professor Kac believes that high schools should not teach college level courses; rather they should teach the standard curricula as thoroughly as possible. This thoroughness will come about only with teachers who are properly qualified, not in education courses, but in their subject. "In many high schools, trigonometry is taught by a person who has had no further mathematics. How can this person emphasize the parts of the course that would be important in further study if he does not know what comes next?" argues Professor Kac.

He states that students in college are properly taught, but that too much time is spent correcting deficiencies incurred in high school.

Professor Kac is a firm believer in federal aid to education. He sees two main sources for college endowment funds in the future: large gifts, which are favored by the income tax laws, and federal aid. He said that 90 per cent of the scientific research carried on by universities is supported by the federal government through agencies such as the National Science Foundation. Also, the federal government indirectly subsidizes faculty salaries by sponsoring research conferences during the summer. If it didn't, he argues, many of the best people would be lost. He strongly believes that there need be no fear of federal control of curricula. The undertaking would be too overwhelming a task, and faculties would never allow it. Professor Kac believes a student loan is the best way to aid students. A loan fund would be self-perpetuating, and the student would gain an increased sense of responsibility.

Professor Kac, whose hobbies include golf, bridge, and a musical instrument, the recorder, now lives in Collegetown with his wife and two children.

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CORNELL SOCIETY OF ENGINEERS

Paul O. Gunsalus

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students, and to establish closer relationships between the College and its alumni."

THE PRESIDENT'S LETTER—

We had another lively and interesting meeting of the Executive Committee at the Engineers' Club on January 17. Walt Hickey, Regional Vice President from Boston was with us, as was Walt Hardy from Chicago and Assistant Dean, John McManus from Ithaca.

The most significant action taken was approval of a proposal of Walt Hardy that the Society sponsor a series of lectures at the College of Engineering at Ithaca. These lectures would be designed to supplement the engineering curricula, with emphasis on fields not covered in the curricula. Walt Hardy was appointed Chairman of a committee to explore this proposal with the Dean's office to work out the practical problems involved. It is hoped that a start could be made on this project next Fall.

Another item that developed considerable discussion was the matter of the mortality rates of the freshman class in the engineering schools. John McManus outlined the various facets of the problem and the steps that the college was taking to improve the situation. This is a matter that is of concern to all members of the Society, both from the standpoint of its effect on our secondary school activities and on the general reputation of the college itself.

A dinner meeting was held in New York on the night of February 1 in conjunction with the Annual Meeting of the A.I.E.E. Our speaker was Harold S. Black, an outstanding inventor from the Bell Telephone Laboratories. His topic was Global Communications Via Artificial Earth Satellites, and was one of great current interest. His presentation raised many provocative questions.

Our next dinner meeting in New York will be the Annual Meeting scheduled for May 4, 1961 at the Engineers' Club, at which Dean Corson will be the speaker.

PAUL O. GUNSALUS

ALUMNI ENGINEERS

Dr. MacCarter Adams

Dr. MacCarter Adams, B.S.M.E. '46, M.Aero.E. '49, has been named one of the Ten Outstanding Young Men of 1960 by the United States Junior Chamber of Commerce for his work on intercontinental missiles.

Dr. Adams' first contribution to aerodynamic theory came while he was still doing graduate study at Cornell. Five years ago he helped to organize a research laboratory for the purpose of solving the intercontinental ballistic missile re-entry problem. As technical director of AVCO research laboratory, Dr. Adams was concerned with how to get a nose cone back through the earth's atmosphere without its being burned to embers. His research on re-entry heat protection has contributed significantly to the achievement of advanced re-entry vehicles, possessing "ablating" nose cones, being launched from Cape Canaveral today. A missile designed according to Dr. Adams' principles was used in the first completely successful intercontinental re-entry test of an ablating nose cone, in April, 1959.

In addition to his work at AVCO, Dr. Adams is a member of the advisory committee on missiles and space vehicles of the National Aeronautics and Space Administration, and has written many authoritative articles which have appeared in more than twenty scientific publications.

Harold M. Jones, M.S. '47 in Agricultural Engineering, an American technician on assignment with the U. S. International Cooperative Administration in India, has played a large part in developing a threshing machine which is simple, inexpensive, easy to operate, and of great potential benefit to Indian farmers. Mr. Jones and another ICA agricultural engineer prepared an initial set of blueprints for such a machine, after which a prototype model was put together with readily available materials. The machine has a capacity of about 460 pounds per hour and operates on a two-and-a-half to three horsepower engine, a type readily available, since the engines are used by many Indian farmers for irrigation purposes. Several Indian manufacturers have become interested in the machine and have built their own prototypes prior to production.

John N. Beckley, C.E. '35, Vice-president and Eastern District Manager of the Austin Co. since 1955, has been named manager of international operations of this engineering and construction firm, with responsibility for all its activities outside North America, including active projects in England, France, Belgium, Brazil and Argentina.

William L. Everitt, M.E. '21, is the new dean of engineering at University of Illinois. He was also chosen one of sixty of the country's leading scientists, engineers, industrialists, and educators to serve on the Army scientific advisory panel

New Delhi, India— Harold M. Jones, right, American technician on an assignment in India with the U.S. International Cooperation Administration demonstrates how sheaves of wheat are fed into the threshing machine.

which assists the Secretary of the Army and the chiefs of staff in providing a ground fighting force which is effective, economical, and progressive, so far as scientific, technological, and industrial resources permit. Mr. Everitt was appointed to the panel in April 1959, and this last October attended the annual fall meeting at The Armor Center, Fort Knox, Kentucky.

Dr. William E. Parkins, Ph.D. '42, formerly director of the organic reactors department for Atomics International, a division of North American Aviation, Inc., was named associate technical director of the division in December by Dr. Sidney Siegel, vice president.

Dr. Parkins will share the responsibility for direction of Atomics International's development programs, particularly in the fields of advanced nuclear reactor systems and new technologies.

Dr. Parkins joined North American in 1948. He was chief of engineering for Atomics International until March, 1959.

A native of Bozeman, Montana, he received a B.S. degree in electrical engineering from Montana State College in 1937. He was a McMullen Research Scholar at Cornell University where he received a doctorate in physics in 1942.

From 1942 to 1946 Dr. Parkins was associated with the Manhattan District Project at the University of California Radiation Laboratory, Berkeley, Calif., and at Oak Ridge, Tenn. In 1946 he became an assistant professor in the physics department of the University of Southern California.

Dr. Parkins is a director of the American Nuclear Society and a Fellow of the American Physical Society. He also is associated with the American Association for the Advancement of Science, and with Phi Eta Sigma, Phi Kappa Phi, Sigma Xi and Tau Beta Pi, national honorary societies.

Allen S. Ginsburgh, B.M.E. '46, a veteran staff member of the Polaris project at Aerojet General Corporation, has been appointed manager of the firm's materials and fabrication division for the solid rocket plant at Sacramento. An Aerojet employee for nine years, Mr. Ginsburgh has been in the Polaris program for the last three and a half years. He helped develop the Polaris material and fabrication program for the solid rocket plant and more recently served as chief staff engineer, with responsibility for direction of the Polaris reliability and administration departments. After receiving his B.M.E. degree from Cornell in 1946, Mr. Ginsburgh got the M.S. degree at Harvard in 1950. He was later assigned by Aerojet to the Oak Ridge School of Reaction Technology. After graduating from the School, he took an active part in Project Rover, acting as liaison for Aerojet with the Livermore Laboratory of the University of California. Mr. Ginsburgh has also worked with an electronic engineering firm and with United Aircraft's research division in Connecticut.

Charles M. Huck, '34, consultant in industrial design, has just opened a new office in New Brunswick, New Jersey, in addition to the present office in New York City.

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COLLEGE NEWS

Edited by Joel Lichtenstein, EE '64

PROFESSOR BOOKER DESCRIBES MAGNETOSPHERIC WAVEGUIDES

A new method of radio communication between the northern and southern hemispheres—a method which could also be used to gain detailed information about outer space—is being explored by a University scientist.

Prof. Henry Booker, Director of the School of Electrical Engineering and Associate Director of the Center for Radiophysics and Space Research at the University, recently described this new method in Boulder, Colorado at scientific meetings sponsored jointly by the United States National Committee of the International Scientific Radio Union and the Institute of Radio Engineers.

It is possible for magnetospheric waveguides to guide high frequency waves between the northern and southern hemispheres over paths that pass thousands of miles into outer space, according to Professor Booker.

Prof. Thomas Gold, chairman of the Astronomy Department and director of the Space Center at Cornell, said that the earth's magnetic field controls the motions of the extreme outer atmosphere so as to filament the plasma into millions of magneto-ionic ducts. These waveguides extend from the ionosphere in the northern hemisphere via the part of outer space known as the magnetosphere.

For the past year and a half Professor Booker has been investigating the possibility of using magnetospheric ducts as an agent in guiding high frequency radio waves between the two hemispheres. This investigation has been supported by a grant from the Atmospheric Sciences Division of the National Science Foundation.

Professor Booker studied the size and strength of the magnetospheric waveguides and their method of operation, using methods of analysis similar to those employed for studying the waveguides used in microwave-engineering. He was able to establish that these magnetospheric waveguides are capable of guiding high frequency waves between the northern and southern hemispheres over channels that reach thousands of miles into space. Although such ducts may well be more than 10,000 miles in length, radio waves leave them with practically the same strength as they enter.

Exploitation of these radio ducts at high frequency wavelengths will permit scientific investigations of outer space from the surface of the earth and from satellites, in a detailed manner hitherto unavailable to scientists, according to Professor Booker.

Ducts originating in polar regions run phenomenal distances into outer space, says Professor Booker, who adds that it is impossible to predict what may be discovered by systematically listening and probing along these naturally available channels into space.

CORNELL ARCHITECTS PLAN RESORT IN BAHAMAS

Despite the wintry weather on campus, a few students are enjoying, at least in their imaginations, the warm, sunny climate of the Bahamas.

They are busy with maps, charts and aerial photographs, designing a major industrial and resort center for Freeport, on Grand Bahama Island—some 60 miles east of Palm Beach, Florida.

Students of Professor Frederick W. Edmondson, they are enrolled in City Planning Design, a graduate course in the department of city and regional planning of Cornell University's College of Architecture.

A special 99-year lease between the Government of the Bahamas, a British colony, and the Grand Bahama Port Authority, gives the development rights of some 130,000 acres to the Port Authority. A deep-water harbor has been dredged, and the Port Authority plans an attractive community for industry, tourism, and permanent residence.

The Authority asked Professor Edmondson whether his class would be interested in designing such a community, and the Cornell professor visited the island last winter to make preliminary investigations and to consult with the Port Authority before deciding to undertake the project.

The project is purely an educational exercise for the students, and there is little chance that any

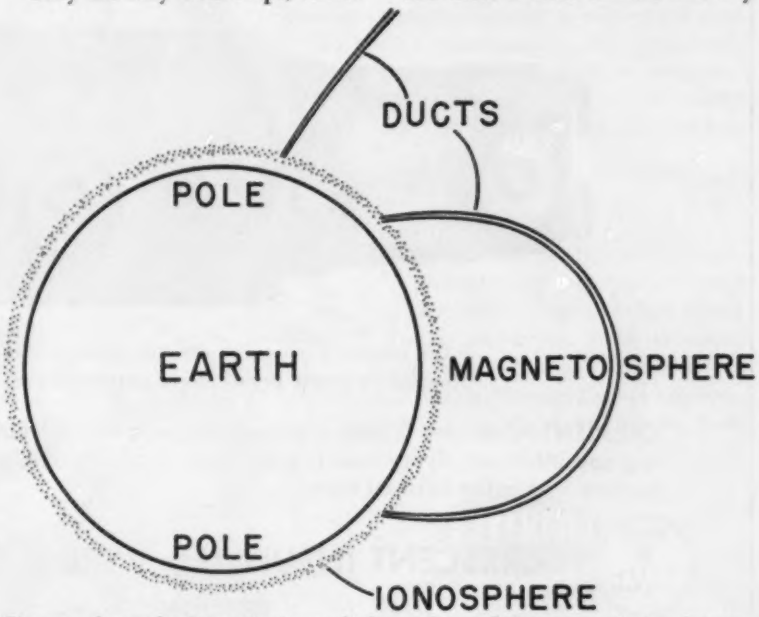

Diagram shows the Magnetosphere which can be used for communication between hemispheres.

of their plans will be carried out, Professor Edmondson comments. Nevertheless, the final plans will be presented to the Authority, and the professional planners who eventually develop the island will doubtless consider the students' ideas in their own plans.

Similar projects undertaken as academic exercises by the class in other years have proved of value to the students and to professional people. They have included plans for Waikiki Beach; Brazilia, the new capital of Brazil; a city in Colorado to serve as the center of a future oil shale industry; and an industrial city designed for protection against nuclear attack.

The general plan for developing the island calls for a balanced community with an emphasis upon tourism, but with facilities for port-oriented industries, agriculture, and permanent residential areas as well. Eventually it is expected that between 100,000 and 200,000 persons will make their homes in Freeport.

In their development plans, the students will give special attention to the problems of retired persons, who can find in Freeport an ideal and healthful climate in which to retire. Several technical problems are being considered by the students: the problem of finding fresh water; communications problems; and the difficulties of preserving the natural beauty of the island. Although no water *shortage* is foreseen, methods of converting salt and brackish water into fresh water will be considered by the students. Research into transportation and communications will also play a significant role in the planning. Because of the importance of attracting tourists to the island, the students will consider hotels, beaches and other accommodations for visitors.

Professor Edmondson directs the project with the assistance of Bruce Hyland, a graduate assistant. Participating are sixteen planning students, including several foreign students, whose undergraduate backgrounds are in architecture, engineering, language, sociology, government, economics, and geography. Thus, each student contributes knowledge of his own field to the planning.

The class is divided into two groups which compete against each other in presenting plans for the island. All assignments and research are taken care of by the students themselves, with the professor serving as advisor. Eventually the best of both plans will be incorporated into the final presentation, drawings and model to be prepared by the students.

The methods being used are similar to those of a functioning professional planning group, and provide experience on how such groups operate. Whenever possible, experts from outside are consulted: Reeshon Feuer, associate professor of agronomy at Cornell and world-famed in his field, and Ta Liang, air photograph interpretation expert and transportation engineer, have contributed advice. The greatest material advice, however, has come from the administrative and technical staffs of the Grand Bahama Port Authority, Professor Edmondson says.

The final publication and model will be presented to the Port Authority officials either in New York City or at Cornell in March 1962.

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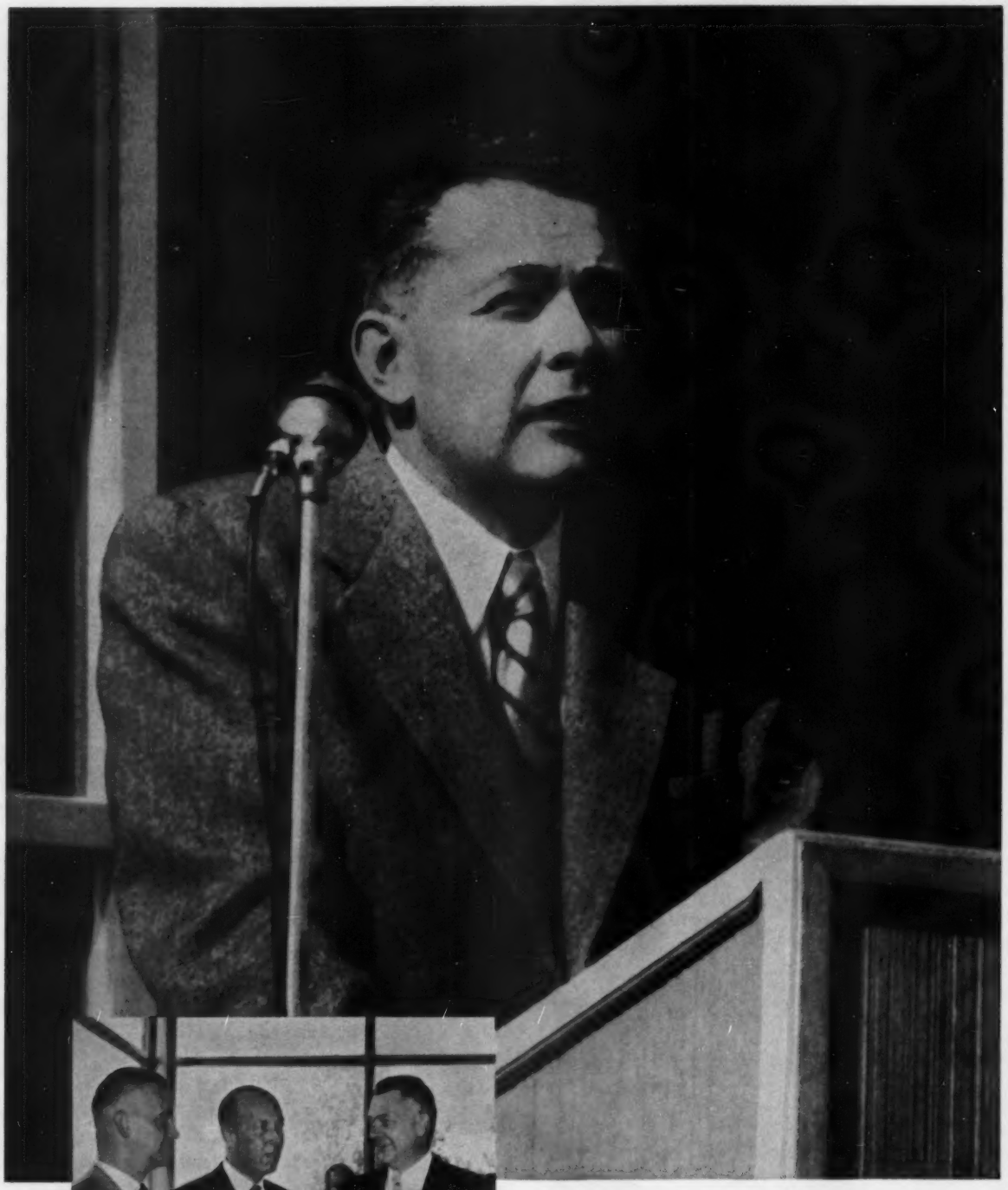


Could this be a picture of you tomorrow? In the fall of 1958, it was Jack Carroll, principal speaker at the opening of Electronic Associates' modern new plant in Long Branch, N. J.

Jack Carroll (*right*) discusses the new equipment he has just seen during a visit with Henri Busignies, President of ITT Laboratories (*center*) and Anthony Pregliese, ITT Public Relations.

TECHNIBRIEFS

Edited by Richard Epstein, EE '63

LARGE MAN-MADE DIAMONDS PRODUCED

"For the first time in history, man has made large diamonds," according to Dr. Guy Suits, General Electric vice president and director of research. The large diamonds are over a carat in size, dark in color, and, because of structural imperfections, are not yet of sufficient mechanical strength for industrial application.

Photo Science

A group of carat-sized diamonds made by scientists of the General Electric Research Laboratory seen against a one inch scale. These large diamonds are dark in color and are not yet of sufficient mechanical strength for industrial application. They are the latest advance in GE's diamond-making research program.

Large diamond work is still in the early development stage. "It is impossible to predict when we will succeed in making large diamonds with mechanical properties comparable to our small diamonds, which have proved to be superior to natural diamonds for many industrial applications," Suits said. He observed that man-made industrial diamonds are of the utmost strategic importance today. The major source of natural diamonds is the Congo; uncertain conditions there demonstrate how fortunate it is that industry can turn to man-made diamonds for many of its needs.

"We have enjoyed steady advances in our diamond-making program," Suits revealed. The first diamonds were dark in color, and only thousandths of a carat in size – about the size of fine grains of sand. This size is needed for many cutting, grinding, and polishing applications in industry. The transition from laboratory to full-sacle production of these small diamonds was made in two years.

In response to industrial needs for larger diamonds, General Electric has succeeded in increasing its control over the size, mechanical quality, and shapes of its diamonds, according to Suits. He announced for the first time that "General Electric can now make, in the laboratory, diamonds up to 1/10 of a carat in size that are of excellent industrial quality." Stones of this size are needed for metal-bonded diamonds wheels and saws. "However, these 1/10 of a carat diamonds are not yet available commercially," Suits pointed out.

GLASS PIPING USED FOR SHOCK WAVE TESTS

Head-on collision of two shock waves traveling eighty times faster than sound has been achieved in a hydromagnetic tube made of glass. Boeing Airplane Company scientists developed this unusual use for glass piping in a study of high temperature gases. The tests are being conducted at the Boeing Scientific Research Laboratories, Seattle, Washington.

The glass tube, manufactured by Corning Glass Works, is 12 feet long and 6 inches in diameter. Boeing scientists believe it is the largest tube ever used in an experiment of this kind. Because the tube is transparent, still photographs can be taken of the colliding shock waves. At impact, the Pyrex piping is brightly illuminated. The naked eye catches only a brief flash, the camera, with shutter left open in a darkened room, records the collision. The flash is accompanied by a loud report similar to an exploding firecracker.

The shock waves are driven through the glass piping by a surge of electrical power equal to the output of four Grand Coulee Dams. The electrical energy used to create the waves is stored in two 20-capacitor banks rated at 20,000 volts with a combined peak power of between 2,500,000 and 5,000,000 kilowatts.

Once triggered, the shocks last only a few microseconds, but create a gas temperature within the tube of approximately one million degrees.

Boeing said the thermal as well as the magnetic energy in the electrical discharge creates shock waves which initially race along at 300 times the speed of sound. After traveling about 60 inches to-

ward the center of the tube, however, both shock waves are "slowed" to about eighty times the speed of sound – still more than twenty-four times the speed of a rifle bullet. Through the glass, the velocity of the shock waves and spectra of radiation from the gas are recorded with a high-speed rotating mirror camera. Boeing also is using a new vacuum ultraviolet grating spectrograph to evaluate the data.

CROSS-LINKAGE OF NATURAL RUBBER STUDIED

The physical properties of cross-linked rubber are being investigated at the National Bureau of Standards. The random chains of natural rubber were oriented by rapid stretching at 80°C, and cross-linkage was effected in both random and oriented chains by exposure to gamma radiation. The same amount of radiation produced twice as much cross-linkage in oriented chains as it did in random chains. The isotropic length of cross-linked oriented chains was found to increase with increased cross-linkage while that of cross-linked random chains was unchanged. Cross-linking of random chains produced a large depression of the isotropic melting temperature, whereas little change was noted for cross-linked oriented chains.

DIFFRACTION USED TO MEASURE LATTICE TILTING

When a polycrystalline metal is plastically strained, the resulting deformation may be a bending or tilting of the atomic lattice within the grains of the metal known as misorientation. The National Bureau of Standards has recently developed an X-ray diffraction method for obtaining quantitative measurements of this deformation. Such data will be used in studying the mechanical properties of metals.

TV USED IN ASTRONOMY

Television has helped an astronomer to record the light (picked-up by the University of Arizona thirty-six-inch telescope) issuing from the Globula Cluster M 15 tens of thousands of years ago. Television is said to be more sensitive than a photographic plate by a factor of 50 to 100—in other words, exposures have to be 50-to-100 times longer with photography. Thus, television makes it possible to take more pictures.

BIGGEST GRAPHITE CYLINDER CORED

The biggest graphite cylinder ever made is a 7-ton behemoth measuring 61 inches in diameter and 72 inches long. One of five such giants produced by National Carbon Company, Division of Union Carbide Corporation, the cylinder will be cored to make sections for a large graphite tower in which elemental phosphorous will be burned for the production of phosphoric acid by a leading chemical firm.

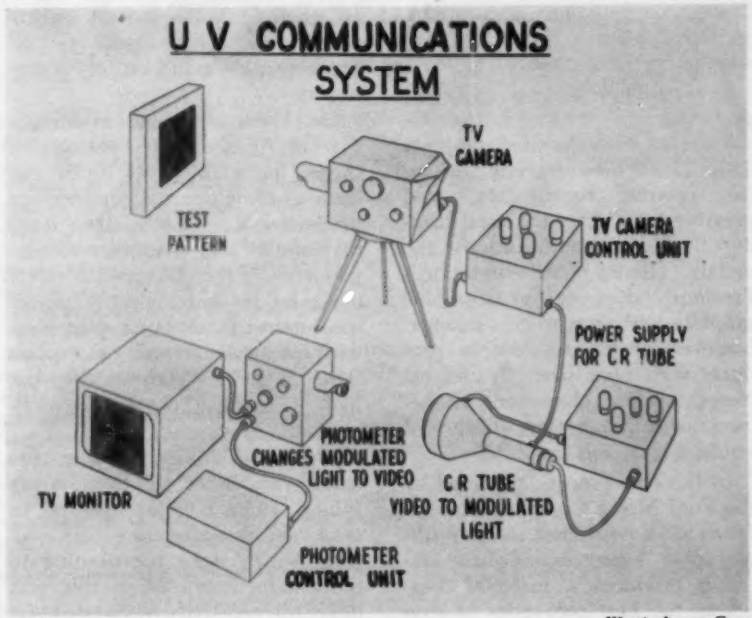
High-temperature process equipment of essentially monolithic construction is made possible by the production of fine-grained graphite in this unprecedented large size. Simpler field erection and lower maintenance costs result from minimizing the number of joints required in fabricating structures for the chemical processing, nuclear, metallurgical, and aircraft industries.

COMMUNICATIONS SYSTEM USES ULTRAVIOLET RADIATION

Work by the Westinghouse Electric Corporation to develop methods for using ultraviolet light to communicate over great distances in free space has enabled the company's air arm division to build and demonstrate a system for transmitting images and other information over an ultraviolet carrier.

The experimental system employs a standard Westinghouse cathode ray tube as both a source and a modulator of ultraviolet. A conventional ultraviolet-sensitive photomultiplier is used to receive the transmission. Input signals are supplied to the system by a standard television camera and the output image is displayed on the screen of a standard television receiver. The significance of the installation is the indication that it will soon be feasible to use cathodoluminescent devices as virtual point-source generators of ultraviolet radiation at the outputs and in the narrow bandwidths necessary for space communicattion.

The attention being given to ultraviolet space communications systems results from the belief that ultraviolet will prove superior to



Westinghouse Corp.

Schematic of new Westinghouse experimental system for transmitting video information via modulated ultra-violet radiation.

infrared or radio frequency in several respects. Chief among these are the extent to which the extremely short ultraviolet wavelengths can be beamed by compact optional reflectors to achieve antenna gains of several million, and the extent to which ultra-violet systems are free from celestial and thermal noise.

METAL-BONDED GRAPHITE USED FOR MECHANICAL BEARINGS

Development of new metal-bonded graphite materials which combine the strength of metals with the unique anti-friction properties of graphite was revealed recently during a seminar on powder metallurgy sponsored by the American Institute of Metallurgy, Mining and Petroleum Engineers.

Potential application of the new materials lies in the field of dry and externally lubricated bearings. Graphite-rich compositions of the new materials have shown strengths superior to the best strengths of pure graphite materials. They offer improved mechanical properties, close dimensional control of parts and can be made by high-volume powder metallurgy techniques. The new compositions have strengths that compare favorably with the best strengths obtained in porous metal compositions used for externally lubricated bearing applications, and have a much higher range of satisfactory performance.

Conventional powder metallurgy techniques are used in the production of metal-bonded graphite materials. These include mixing the powder constituents, cold pressing into "compacts" and heating the compacts to liquify the metal, (liquid-phase sintering.) Previous attempts to combine graphite with iron in this manner, however, always resulted in products with poor strength and extremely brittle characteristics because of the poor compatibility of liquid metals and graphite.

In the new process, patented by the Ford Motor Company, the addition of a powdered calcium-silicon alloy during liquid-phase sintering produces a material combining the best properties of iron and graphite. Compositions have been prepared that range from 40 to 90 per cent graphite by volume.

In addition to the liquid-phase sintering of iron-graphite compositions, nickel, cobalt, copper, silver, and aluminum-graphite combinations have been made successfully. Research has been conducted by Dr. Michael Humenik, Jr. of the Ford Motor Company's Applied Science Department.

TWO NEW PIEZOELECTRIC COMPOUNDS DISCOVERED

The discovery that zinc oxide and cadmium sulfide are strongly piezoelectric has just been revealed by A. R. Hutson of Bell Telephone Laboratories. In order to demonstrate the piezoelectricity in zinc oxide, it first had to be "doped" with lithium to neutralize the excess conductivity which has masked the effect till now. The degree of piezoelectricity exhibited by the doped zinc oxide is about four times as great as that of quartz, while the cadmium sulfide is twice as great. Confirming measurements were made on single crystals of zinc oxide grown both by vapor techniques and from a flux. The cadmium sulfide crystals were vapor grown.

Both zinc oxide and cadmium sulfide have long been recognized as n-type semiconductors. Zinc oxide in fact usually shows a room temperature resistivity less than 10^3 ohm-cm. This relatively low resistivity effectively shorts out all experimental evidence of piezoelectricity.

Dr. Hutson decided to investigate the piezoelectric constants of these materials while studying some of their unusual conductivity properties, especially the large magnitude and temperature dependence of the phonon-drag effect observed in thermoelectric power measurements. A large piezoelectric constant seemed to explain these anomolies theoretically, but had never been observed experimentally.

The conductivity of the zinc oxide was "quenched" by diffusing lithium atoms into the material, to act as acceptors for the excess electrons which were contributing to the conductivity. When this was done, the resistivity of the material was raised from 10^3 to 10^{12} ohm-cm at room temperature.

Resonance-antiresonance measurements and direct squeeze measurements were made on vapor-phase grown needles and flux-grown platelets of zinc oxide, and on the vapor-phase grown cadmium sulfide. With dielectric constants of eight point two and nine for ZnO and CdS respectively, electromechanical coupling coefficients were calculated to be approximately point four for ZnO and point two for CdS, compared with 0.095 for quartz.

ULTRA HIGH SPEED COLOR FILM DEVELOPED

A recently introduced color motion picture film that can be used in high speed cameras with exposures as short as 1/50,000 of a second has been described by Eastman Kodak Company. The color film has a tungsten light speed of 125. It can be used interchangeably with Kodak Tri-X black-and-white reversal film, which has been the accepted Kodak film for high speed photography.

The film's color differentiation affords additional data and information in the ultra-slow-motion movies that result from high-speed photography. High-speed photography is used in the study of rocket firings, arc welding, and other events that happen too fast for the human eye to see.

This film has the ability to record information in such low light levels that the transparency appears almost black. By making a print on Ektachrome Reversal Print Film with printer exposures up to 40 times normal, the information recorded on the original film can be salvaged in such a way that color and brightness differentiations are retained and much of the recorded data becomes usable. Previous color films required so much light for proper exposure in high speed motion picture cameras that heat from the flood lamps could damage the object being photographed. Thus color photography was usually used only for self-luminous subjects such as flame studies.

This higher sensitivity film will enable scientists and industries to utilize color photography in more diverse applications than heretofore possible.

Research at Cornell . . .

SCIENTISTS PROBE LANGUAGE BARRIER

A new research program, aimed at solving the language problems of the natives of the high Andes of South America, has been established at Cornell University.

It will focus on the problem of improving communications between the government agencies of Peru, Bolivia and Ecuador, where Spanish is the national language, and the more than five million Indians of the Andean highlands who speak only Quechua, the language of the ancient Inca empire.

A long-range project of training, field research and experimentation, the Quechua Language Program will be directed by Donald F. Sola, professor of linguistics at Cornell. The University has received a Rockefeller Foundation grant of $155,000 to support the program for the next four years.

With these funds, five Peruvians and one Bolivian will be brought to Cornell for graduate training in linguistics, anthropology, community development and educational research methods. As part of their training they will work with Professor Sola in developing materials and methods for a field experiment in fundamental education at Chinchero, an Indian community near Cuzco, the old Inca capital. The Chinchero experiment will begin in 1963.

History of the Region

The vast Andean empire which Pizarro found and conquered stretched from present-day Ecuador to northern Argentina. The society was largely socialistic in organization; the Inca's subjects had little private property and contributed much of their labor to such imperial projects as the famous royal roads which spanned the Inca dominions.

Under Spanish rule the pattern of land ownership changed somewhat, and many large private estates were established, but the Indian remained an illiterate peasant, living in poverty, misery, and poor health and bound to the service of his lord.

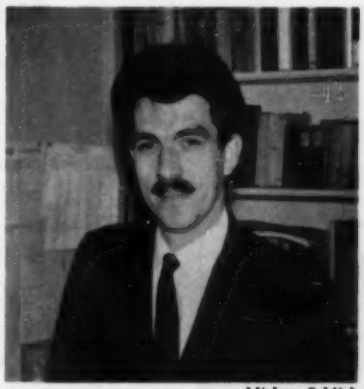
For nearly a century and a half the Andean countries have been independent, and during this time great changes have taken place. Through intermarriage, the spread of education, and a more enlightened public attitude, the lives of many Indians have been improved.

But still today almost half the population of Peru, Bolivia, and Ecuador is underprivileged. In the Indian communities of the high plateaus and remote valleys of the Andes, few Indians can read or write, health conditions are poor, and the peasant farmer may earn as little as ten cents a day.

The Andean governments recognize that such conditions create a potentially explosive situation. They are anxious to improve living conditions, level of education and productivity among the Indians, but are hampered by limited funds, lack of technicians, and two important natural obstacles—the wild, rough Andean terrain and the language difference.

This last obstacle—the fact that literally millions of Quechua Indians do not speak Spanish—will be the main object of the Cornell program.

The first phase of the program will be restricted to Peru, where proposed field experiments will test the extent to which Quechua itself can be used for teaching in the Quechua schools. Professor Sola is also interested in applying the improved language teaching techniques developed in the United States to the task of teaching Spanish to the Quechuas.



Mickey Schlick

Professor David F. Sola

The researchers will also test different alphabets for writing Quechua, since no alphabet has been accepted as official, to see which one might be most useful in teaching.

Professor Sola made a study of Quechua dialects in Peru and Bolivia last year under a Rockefeller Foundation grant, and personally chose the Latin Americans who will participate in the first part of the program.

He feels that the fact that these persons will be trained on a project designed to solve a practical problem in their own countries may be the greatest contribution of the program. They will return to their own countries prepared to speak with government officials about ways of coping with the language problems and to train other Latin Americans as language technicians.

Two project members are already at Cornell: Antonio Cisihuaman, a native of Chinchero, and agricultural specialist at the school there, and Florian Luque, a literacy specialist from Cochabamba, Bolivia. Others, who arrived in January are: Carlos Delgado, assistant to the Director of Fundamental Education, the Peruvian Ministry of Public Education; Abner Montalvo, specialist in Indian community development in the Peruvian Ministry of Labor; and Dr. Alberto Escobar, professor of philology at San Marcos University, Lima.

Professor Sola hopes that as a result of the program a Peruvian center for instruction and research in applied linguistics will be established which, when staffed with teachers and technicians trained in the program, could serve the needs of all countries in which Quechua is spoken.

In the future he hopes to extend the program to cover Aymara, another Indian language spoken by about 1,500,000 Indians of Peru and Bolivia, and to experiment with ways of using this language and Quechua in fundamental education via mass media such as radio.

562 PROGRAMS, PROJECTS & STUDIES AT HUGHES

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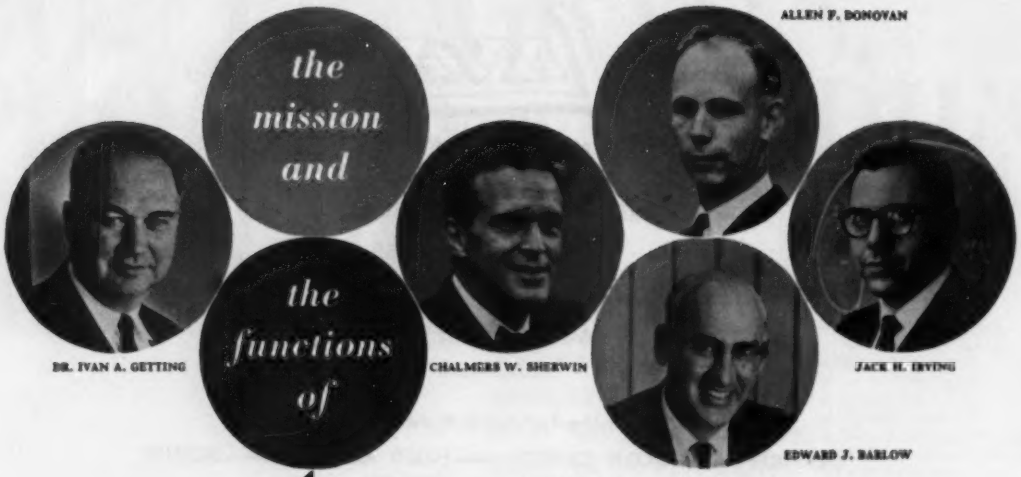

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FIFTY YEARS AGO IN THE ENGINEER

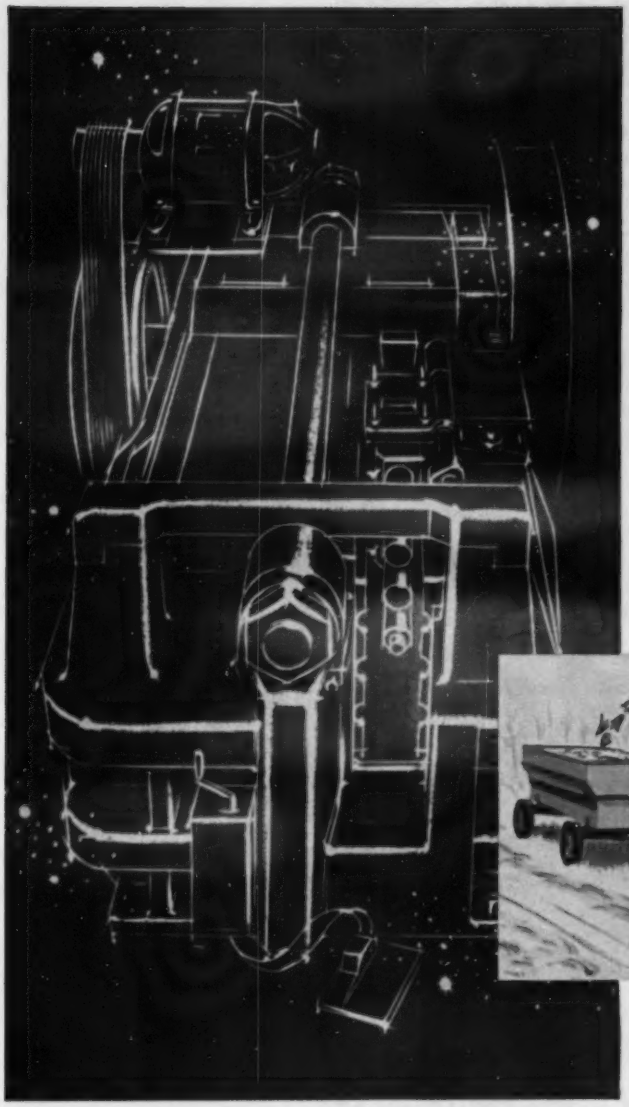
Edited by Dale Henderson, EP '64

There seems to be no doubt that it is becoming increasingly difficult from year to year for graduates of mechanical and electrical engineering courses to get a start in business. About the only concerns making demands for recent graduates are those offering special apprenticeships at wages little above those paid ordinary trade apprentices having scarcely a common school education. *The Sibley Journal, February 1911*

A system of multiplex telephony has been invented by Maj. G. O. Squier, Signal Corps, U. S. Army, according to *Engineering News*. It is claimed that the system permits of the transmission over a single wire of a number of telephonic conversations limited by the different frequencies to which the several telephone circuits may be attuned. An earth return is claimed to be possible through the use of electrical condensers of such capacity that great impedance is offered to the reception of external disturbances which would be audible. Maj. Squier proposes to use frequencies of 15,000 to 20,000 cycles per second, which are just beyond the limits of audibility. These sustained oscillations are not used directly and they do not affect the diaphragm of a telephone receiver. The ordinary microphone transmitter and induction coil are used to impose changes in amplitude on the sustained high frequency oscillations, corresponding to the details of speech. These changes affect a "detector" such as is used in wireless telegraphy, which permits the passage of a correspondingly varying current, from a separate source through the listener's receiver circuit. The several talking circuits connected to the single transmission wire can be adjusted, by varying their induction and capacity, to pick out only a certain desired frequency and they will not respond to other frequencies. The very high frequencies used have been obtained, in Maj. Squier's experiments, from a special generator made by the General Electric Company. This machine has a capacity of 2kw and can be run up to 100,000 cycles per second. *The Sibley Journal, February 1911*

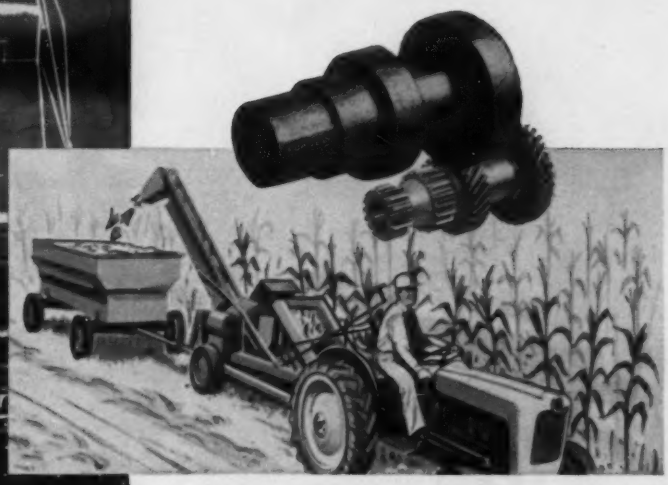
An aeroplane flight from Key West, Florida, to Havana, Cuba, was attempted on January 30 by J. A. D. McCurdy. After coming eighty miles, and when still ten miles from Havana, the supply of lubricating oil was exhausted and it was necessary to descend to the sea. The aeroplane was equipped with pontoons for this contingency and the machine safely rode the waves until the aviator was rescued by the torpedo boat destroyer "Pauling" which had been detailed to accompany the aeroplane. The machine was taken aboard and another attempt to cross will be made soon. *The Sibley Journal, February 1911*

The plan for raising the wreck of the Maine is to surround the wreck, about 325 feet in length, lying in thirty-seven feet of water, with a dam which shall be tight enough and strong enough to enable work to be safely carried on under its protection, according to *Engineering News*. This dam must be self-sustaining. There is no way of bracing it to resist the water pressure behind it by struts against its interior. The borings show that for a depth of eighteen to twenty feet the bottom of the harbor is a soft-semi-liquid mud. Below that for some twenty-five to thirty feet there is soft blue clay. The building of a dam which will sustain a head of thirty-seven feet of water on such a foundation is a task so unprecedented that it may well excite the interest of engineers generally. The dam must not only be self-supporting and safe against the pressure to which it is exposed, but it must be capable of complete removal after it has served its purpose. The plan which the Board of Army Engineers has adopted is to sink around the wreck a series of large cylinders of interlocking steel sheet-piling. These cylinders are to be fifty feet in diameter along the sides of the wreck and forty feet at the bow and stern. The sheet-pile cylinders are to be sunk to a depth of seventy feet below the surface, which means that their lower ends will have about thirty-three feet penetration in the bottom. After these cylinders have been sunk, a dredge will dig clay from shoals in the harbor and deposit it in the hopper scows. These scows will be towed over to the cofferdam, and their loads of clay will be deposited in the cylinders until they are full. The interior of the cofferdam will then be pumped out. *The Sibley Journay, February 1911*



Upsetter, or horizontal forging machine

RESISTANCE TO PUNISHMENT of any severe-service part increased by designing it to be forged



Gear blanks for tractor and farm implement transmissions are designed to be upset-forged, usually with integral forged stub shafts. Forging gives these vital parts maximum resistance to gear-clashing shifts. Transmission life can be equal to equipment life when gears are FORGED.

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UNION CARBIDE

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STRESS *and* STRAIN . . .

Edited by Delia Corkey, EP '64

FINAGLE'S UNIVERSAL LAWS FOR ENGINEERS

Axiom 1: In any calculation, any error which can creep in will do so.

Axiom 2: Any error in any calculation will be in the direction of the most harm.

Axiom 3: In any formula, constants (especially those obtained from engineering handbooks) are to be treated as variables.

Axiom 4: The most vital dimension of any plan or drawing stands the greatest chance of being omitted.

Axiom 5: If only one bid can be secured on any project, the price will be unreasonable.

Axiom 6: If a test installation functions perfectly, all subsequent production units will malfunction.

Axiom 7: Parts that positively cannot be assembled in improper order will be.

Axiom 8: Interchangeable parts won't.

Axiom 9: If more than one person is responsible for a miscalculation, no one will be at fault.

Axiom 10: Identical units which test in an identical fashion will not behave in an identical fashion in the field.

Axiom 11: If, in engineering practice, a safety factor is set through service experience at an ultimate value, an ingenious idiot will promptly calculate a method to exceed said safety factor.

Axiom 12: Warranty and guarantee clauses are voided by payment of the invoice.

• • •

Nietzche is peachy,
but Freud is enjoyed.

• • •

The censors of the cinema have never given proper credit to a group probably more responsible for keeping sex out of the movies: ushers.

The sultan kept his harem several miles away from his palace, and each day he sent a trusted servant to fetch one of the wives. The sultan lived to be 87; the servant died at the age of 40.

Moral: It's not the women who kill you, it's the running after them.

• • •

Science is making so many strides ahead, almost daily, that it becomes increasingly difficult for the layman to keep up. Latest invention we've heard about is a toothpaste with built in food particles for people who can't eat between brushing.

• • •

Five editors of a well-known Engineer were sitting at a board meeting and while waiting for the arrival of a sixth, one suggested they play a game. "Let's tell our major vice," he said, "Mine's drink."

"Mine's gambling on the horses."

"Mine's cribbing on my exams." (from a Tau Bete.)

"Mine is awful—I like to date married women."

The fifth refused to tell. When the others insisted, since they had told theirs, he reluctantly gave in: "Mine is gossip, and I can't wait to get out of here!"

• • •

Here is a good test for your stomach muscles; stated the ad in a physical culture magazine: Clasp your hands over your head and place your feet together on the floor. Now bend to the right at the waist as you sit down to the left of your feet. . Now by sheer muscular control, haul yourself up, bend to the left and sit down on the floor to the right of your feet. Keep this up and let us know the result. The first letter said: "Hernia."

• • •

Advice to the exhausted: When wine, women, and song become too much for you, give up singing.

Women are the problems that most men like to wrestle with.

• • •

The reason no one ever gives the groom a shower is that everyone figures him to be all washed up anyway.

• • •

Unabashed dictionary: The sport of kings is queens.

• • •

The difference between a married man and a bachelor is that when the bachelor walks the floor with a babe in his arms, he's trying to sober her up.

• • •

The bright young thing wants to know if infants enjoy infancy as much as adults enjoy—Who threw that?

• • •

If all the world loves a lover, why do they have hotel detectives?

• • •

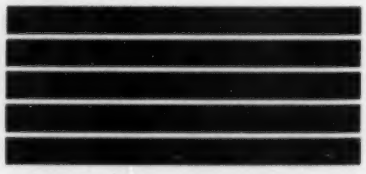
Three old men were discussing the ideal way to die. The first, aged 75, wanted to crash in a car doing 95 mph. The second, aged 85, wished to end it all in a jet plane doing 600 mph. The third, aged 95, said he had the ideal death. "I'd like to be shot by a jealous husband."

• • •

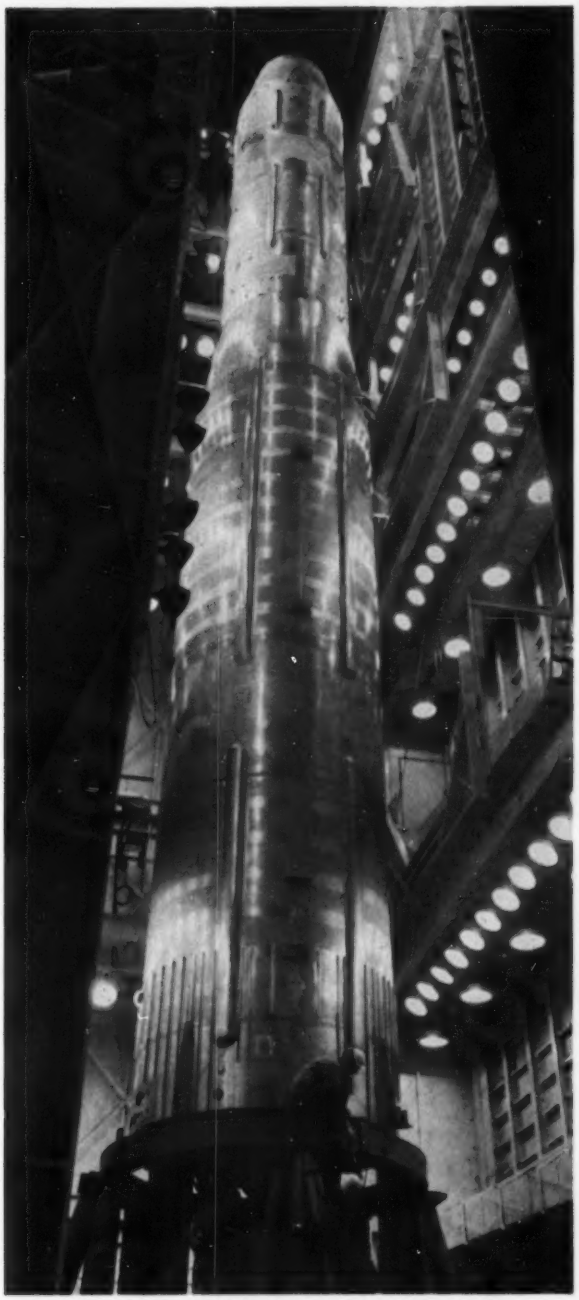
A serious thought for today
Is one that causes us dismay;
Just what are the forces
That bring little horses
If all of the horses say "Nay"?

• • •

In a risky attempt to circumvent any censor, this joke is smuggled in at great risk, just as the magazine goes to press. The author and the printer are the only ones to see it:



If your sights are set  on outer space–



U.S. Air Force I.C.B.M. "Titan" shown in the vertical test laboratory at the Martin Company, Denver, Colorado.

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Qualities I Look For When Recruiting Engineers

Q. Mr. Hill, what can I do to get the most out of my job interviews?

A. You know, we have the same question. I would recommend that you have some information on what the company does and why you believe you have a contribution to make. Looking over company information in your placement office is helpful. Have in mind some of the things you would like to ask and try to anticipate questions that may refer to your specific interests.

Q. What information do you try to get during your interviews?

A. This is where we must fill in between the lines of the personnel forms. I try to find out why particular study programs have been followed, in order to learn basic motivations. I also try to find particular abilities in fields of science, or mathematics, or alternatively in the more practical courses, since these might not be apparent from personnel records. Throughout the interview we try to judge clarity of thinking since this also gives us some indication of ability and ultimate progress. One good way to judge a person, I find, is to ask myself: Would he be easy to work with and would I like to have him as my close associate?

Q. What part do first impressions play in your evaluation of people?

A. I think we all form a first impression when we meet anyone. Therefore, if a generally neat appearance is presented, I think it helps. It would indicate that you considered this important to yourself and had some pride in the way the interviewer might size you up.

Q. With only academic training as a background, how long will it be before I'll be handling responsible work?

A. Not long at all. If a man joins a training program, or is placed directly on an operating job, he gets assignments which let him work up to more responsible jobs. We are hiring people with definite consideration for their potential in either technical work or the management field, but their initial jobs will be important and responsible.

Q. How will the fact that I've had to work hard in my engineering studies, with no time for a lot of outside activities, affect my employment possibilities?

A. You're concerned, I'd guess, with all the talk of the quest for "well-rounded men." We do look for this characteristic, but being president of the student council isn't the only indication of this trait. Through talking with your professors, for example, we can determine who takes the active role in group projects and gets along well with other students in the class. This can be equally important in our judgment.

Q. How important are high scholastic grades in your decision to hire a man?

A. At G.E. we must have men who are technically competent. Your grades give us a pretty good indication of this and are also a measure of the way you have applied yourself. When we find someone whose grades are lower than might be expected from his other characteristics, we look into it to find out if there are circumstances which may have contributed.

Q. What consideration do you give work experience gained prior to graduation?

A. Often a man with summer work experience in his chosen academic field has a much better idea of what he wants to do. This helps us decide where he would be most likely to succeed or where he should start his career. Many students have had to work hard during college or summers, to support themselves. These men obviously have a motivating desire to become engineers that we find highly desirable.

Q. Do you feel that a man must know exactly what he wants to do when he is being interviewed?

A. No, I don't. It is helpful if he has thought enough about his interests to be able to discuss some general directions he is considering. For example, he might know whether he wants product engineering work, or the marketing of technical products, or the engineering associated with manufacturing. On G-E training programs, rotating assignments are designed to help men find out more about their true interests before they make their final choice.

Q. How do military commitments affect your recruiting?

A. Many young men today have military commitments when they graduate. We feel it is to their advantage and ours to accept employment after graduation and then fulfill their obligations. *We have a limited number of copies of a Department of Defense booklet describing, in detail, the many ways in which the latter can be done. Just write to Engineering Personnel, Bldg. 36, 5th Floor, General Electric Company, Schenectady 5, N. Y.* 959-8

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